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SOCIAL CONSEQUENCES OF BUSINESS CYCLES

SOCIAL CONSEQUENCES OF BUSINESS CYCLES

BY

MAURICE BECK HEXTER, PH.D.

Executive Director, Federated Jewish Charities of Boston
Instructor in Social Ethics, Harvard University

WITH AN INTRODUCTION BY

ALLYN A. YOUNG

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TO

MARGUERITE MOCK HEXTER

HER HUSBAND DEDICATES THIS BOOK

IN GRATEFUL RECOGNITION OF

HER AID IN MAKING IT

INTRODUCTION

When different fields of inquiry have been separately cultivated for a while, the borderlands between them often provide fertile ground for new investigations. It is in one of these fruitful borderlands that Dr. Hexter has turned a furrow. His book will be of interest alike to students of the business cycle and to those whose more immediate concern has been with vital statistics and with other records of measurable social phenomena.

This does not mean that the field Dr. Hexter has tilled is altogether new. Ever since Malthus, men have been interested in the response of the movement of the population to variations in economic conditions. In particular the relation between fluctuations of the marriage-rate and the movements of various indexes of economic welfare has been a favorite subject of inquiry. Various statisticians have also given passing attention to such seasonal variations of vital phenomena as are fairly well defined. And in recent years, with growing interest in the problem of the business cycle, several investigators have made preliminary surveys of the cyclical movements of different types of non-economic phenomena.

But although Dr. Hexter has had predecessors, whose results he has been careful to take into account, a large part of what he has accomplished is pioneer work. This shows itself, not only in his results, but also in his methods. He has utilized a compact body of fairly homogeneous materials, relating, for the most part, to a single city. His tools are as precise as any the present development of statistical technique affords. In particular he makes skill-

ful use of the methods Professor Warren M. Persons has perfected and employed in analyzing the temporal variations of economic phenomena. Furthermore, he has done his work with unusual fullness of detail. Statisticians will appreciate the vast amount of labor Dr. Hexter's computations have required.

The general goal of statistical research is the uncovering of the relations that obtain among group phenomena. The particular relations into which Dr. Hexter inquires are those which may exist among the fluctuations in time of various happenings that have economic and social significance. For his criteria he has to rely upon coefficients of correlation. Now these coefficients, although the best measures yet designed, are not in all respects as satisfactory criteria of the degree of relationship between different time series as we could wish to have. Dr. Hexter cautions the reader against inferring more than should be inferred from his results, and his counsel needs to be emphasized and even supplemented.

The most that coefficients of correlation can do is to measure the degree to which likenesses prevail among the various characteristics of different statistical series. They do not establish the existence of relationships of cause and effect. At the few points where Dr. Hexter ventures to suggest causes or to explain the correlations he finds, he has to invoke considerations other than those supplied by the results of his statistical analysis.

Furthermore, in the particular case of time series, such as those with which Dr. Hexter is concerned, the significance of coefficients of correlation is subject to special limitations. Professor Warren M. Persons, writing on the basis of a large experience with such problems, concludes: "Coefficients of correlation are after all merely averages. The specific relationships between two time series are much

more adequately set forth by charts than by numerical measures." Further: "Coefficients of correlation for the various possible pairs of items of time series are useful mainly as a basis for judging the lag of one series with respect to another." Dr. Hexter, it will be observed, supplies charts in generous measure. And he employs correlation coefficients chiefly as tests of lag.

A special degree of caution should be observed in drawing inferences from the coefficients which Dr. Hexter finds in his study of the correlation of seasonal variations. More significance must be attached to a coefficient of given magnitude for the correlation of the cyclical fluctuations of two series than to one of the same magnitude for seasonal fluctuations. It is true, of course, that the size of the coefficients which express the correlation of cyclical movements will depend, in some measure, upon the particular manner in which the secular trends of the different series are determined. But the *fact* of correlation is generally an inference from the observation that, in the two series compared, there are cyclical fluctuations of fairly commensurate duration and often with somewhat similar general contours. The coefficient, as an average, gives a convenient summary of the observed relationship; and coefficients computed for pairings with different degrees of lag serve to indicate, with fair accuracy, the average time interval between the corresponding stages of the cyclical movements of the two series. As Dr. Hexter observes, when the coefficients found for different periods of lag increase steadily as the period which yields the maximum coefficient is approached, and when that coefficient itself is tolerably large, there is good reason for putting reliance upon it.

Coefficients of correlation for seasonal variations do not have so secure a position. In the first place, when monthly

data are used, the coefficients are based on only twelve pairs of items. The probable error of these coefficients, even though it cannot be determined precisely, is, therefore, relatively large. Furthermore, if the two series have strongly marked seasonal peaks, it is likely that, with the appropriate degree of lag, a high coefficient of correlation will be found, even though the connection between the seasonal movements of the two series may be exceedingly tenuous. Thus, using a six-months lag, a high coefficient of correlation would be found between monthly sales of firecrackers and monthly sales of Christmas toys. In a similar way June marriages and the October accumulations of divorce applications help to make four months the period of lag which, as Dr. Hexter finds, yields the maximum coefficient of correlation between marriages and divorce applications.

Again, coefficients of seasonal correlation stand without the support of other evidence, except such as can be had from considerations external to the data under examination (as, for example, the nine-months period between conception and birth). In general the *fact* of correlation, not merely the degree of lag, must be inferred from the coefficients alone. Moreover, as Dr. Hexter is careful to note, maximum correlation, if external considerations are lacking, cannot be associated with a single determinate period of lag. A lag of six months is equally a lag of eighteen months or a reversed lag with a corresponding indeterminate magnitude.

On the other hand, some of the coefficients Dr. Hexter finds for seasonal correlation are distinctly high, and for some of them reasonable explanations are at hand. In default of such explanations, even a fairly high coefficient of correlation establishes merely a *prima facie* case for the existence of some direct or indirect relationship between

the seasonal variations of two series of events. But it is something to have entered a new field of inquiry and to have created a basis for conjectures. And the indexes of seasonal variation which Dr. Hexter has computed are in themselves of great value.

Among Dr. Hexter's findings with respect to cyclical correlations are many things of interest and importance. The portrayal of the cyclical movements of vital phenomena is itself a contribution to social statistics. The largest single question which Dr. Hexter's study of cycles raises has to do with the general nature of the relationship between these movements and fluctuations in business conditions. The coefficients Dr. Hexter has computed for different degrees and directions of lag are distributed in such a manner as to lead him to infer that the cycles in which vital phenomena move precede business cycles rather than follow them. Of course, it is possible to maintain that fluctuations which appear to precede a given business cycle really reflect the influence of the last previous cycle. But Dr. Hexter inclines toward the view that the sequence he finds is real, not merely apparent, and he believes that it may have causal significance. From vital phenomena, through psychology, to business enterprise, he suggests, the line may run. An obvious objection to most of the theories that have sought to explain the cyclical movements of business in terms of alternating states of optimism and pessimism in the business community has been that it is hard to account for such psychological cycles, as they might be called, except on the ground of changes in the fundamental conditions governing the business outlook. Thus, such arguments have seemed to move in a circle. Dr. Hexter seeks to cut the circle and to connect one of its severed ends with climatic or biological changes. He proffers this suggestion,

of course, as an hypothesis, not a conclusion. It is to be hoped that it will stimulate further inquiries.

In fact, it is to be hoped that there will be further attacks upon the other problems Dr. Hexter discusses. Studies like his, monographic in character and dealing with a single locality, might very profitably be undertaken by other investigators. Agreements and differences in the results reached would point the way to definitive general conclusions. If it could be made to fructify in such a manner, the value of Dr. Hexter's work would be greatly enhanced. But it is quite able to stand on its own merits as an important piece of research.

ALLYN A. YOUNG

CAMBRIDGE, MASSACHUSETTS
November 1, 1924

AUTHOR'S PREFACE

THE subjects discussed in this book have engaged the attention of thinkers ever since man began to reflect upon the social aspects of life. The ups and downs of commerce have long engaged the study of economists and business men. Various aspects of business cycles have been explored. Efforts have been expended, and wisely, in discovering the sequence of events and causes of the ebb and flow of business. In the main, however, these efforts have been applied to strictly economic phases of the cycle. Little time has been devoted to analyzing the social consequences of business cycles. Yet these consequences are of transcendent importance. For statesmen, business men, economists, and social workers, the connection between economic conditions and the quantity of the population is important. So, also, are the problems of marriage and divorce; and death is master of all. These subjects are being discussed as never before and in ever-widening circles. This book deals with the connection between these vital topics and variations in business conditions.

The writer is under obligations to many who have aided him throughout the investigation, among others to Dr. William Trufant Foster, of the Pollak Foundation for Economic Research, and to Professor Allyn A. Young, who originally suggested the expansion of the topic and who aided throughout with much advice. Professor Young is a real friend to the young generation of students in this country.

The writer cannot close this Preface without acknowledging the obligation he is under to his mentors and colleagues in the Department of Social Ethics in Harvard University. It has been a pleasure to study and work with Dr. Richard C. Cabot; Professor Robert F. Foerster, now at Princeton; Professor James Ford; and Dr. Niles Carpenter. He also acknowledges the unfailing courtesies of Miss Ruth Carroll, the Secretary of the Department. Finally, it should be said that every page has benefited by the scrutiny and criticism of the writer's wife, for whose forbearance during these labors he is under deep obligation.

Boston, Massachusetts
February 29, 1924

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THE tables in the first part of the volume are numbered according to the following system: Tables 1 to 10 deal with the birth-rate; 11 to 20 with the stillbirth-rate; 21 to 30 with the death-rate; 31 to 40 with marriages; 41 to 50 with divorces. Within each series, also, a definite system is followed. A table which ends, say, in 3, refers to similar tables for other variables. Thus, Table 13 refers to the percentage deviation from the trend of the actual stillbirth-rate, month by month; Table 33 refers to the deviations from the trend of the monthly number of marriages; and so forth. Certain tables which have not been referred to in the discussion, but which are important nevertheless, are in the Appendix. The three charts which summarize other charts, appear white on black on pages 106, 110-111, 162-165.

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SOCIAL CONSEQUENCES OF BUSINESS CYCLES

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PART ONE

SOCIAL CONSEQUENCES OF BUSINESS CYCLES

CHAPTER I

INTRODUCTORY

THE study of the vital, fundamental, inescapable phenomena of human life has gripped mankind from the earliest times. It is quite natural that this should have occurred, since man, throughout the years, has wondered at such phenomena as life and death. The history of early civilization is replete with speculation concerning the vital occurrences of life and death; these speculations are frequently intimately connected, through superstition, with certain definite religious beliefs. It is not strange that this is so since birth and death comprise the ultimate realities of existence. Not alone was this interest manifested by individuals; it was as important for communities. Numbers meant success for early groups in military struggles; they likewise implied difficulties during peace time so far as food supplies were concerned.

This early interest in the quantitative aspect of human society continues to intrigue men, although the reason for such continued and unflagging interest has changed. "The demographic congress of 1877 considered this question as well as that of the relation between sun-spots and mortality." [1] And an English writer has discussed the relationship between death-rates and the orbital motions of

[1] Franz Žižek, *Statistical Averages* (translated by Warren M. Persons), (New York, 1913), p. 365.

Jupiter.[1] Indeed, the early developments of statistical method are intimately bound up with vital phenomena. The "Observations" of Captain John Graunt on the London Bills of Mortality, in 1661–62, and Halley's Breslau Table, thirty years later, show the keen interest of men in these fields.[2] Fifty years later (1741) a Prussian clergyman, J. P. Süssmilch, attempted to formulate a theory of community organization based upon arithmetical calculations, in his volume entitled "Reflections on the Divine Order in the Mutations of the Human Race as Indicated by its Birth, Death and Propagation." [3] One of the most important phases of the various studies on births and deaths has been the economic side of the problem. On the whole, however, most of these studies have dealt with stationary populations; and, where they have not been so restricted, they have not been subjected to statistical analysis as rigorous as is at present available.[4]

[1] B. G. Jenkins, "On a Probable Connection between the Yearly Death-Rate and the Position of the Planet Jupiter in His Orbit," *Journal of the Royal Statistical Society* (1879), p. 330.

[2] *The History of Statistics*, edited by John Koren (New York, 1918), pp. 365–66.

[3] "Betrachtungen über die göttliche Ordnung in den Veränderungen des menschlichen Geschlechts aus der Geburt, dem Tode, und der Fortpflanzung desselben erwiesen." For a brief explanation of Süssmilch, see August Meitzen, *History, Theory, and Technique of Statistics* (translated by R. P. Falkner), (Philadelphia, 1891), pp. 34–36; also J. T. Merz, *History of European Thought in the Nineteenth Century* (Edinburgh and London, 1912), vol. II, p. 563, footnote.

[4] See the following very interesting volumes: A. M. Carr-Saunders, *The Population Problem* (Oxford, 1922). This volume deals with both the quantity and quality of population. Harold Cox, *The Problems of Population* (New York, 1923). He foresees inevitable reduction in standards of welfare unless the growth in population is restricted in the near future. Edward M. East, *Mankind at the Crossroads* (New York, 1923). Professor East devotes his volume specifically to the quantitative side of population. From a survey of the facts of population, he comes to the conclusion that the law of diminishing returns in food production, so far as the white groups are concerned, has set in very decisively. The maintenance of the present level of welfare and stability is dependent upon conscious restriction of the birth-rate.

Of far greater interest to citizenry is the study of these social phenomena over a long span of years. Now it has long been known that there is a very close kinship between fluctuations in phenomena of social life and variations in economic well-being. Some recognition has been given from time to time to that relationship. The principal phenomena which have been studied are births, deaths, marriages, divorces, various aspects and forms of criminality, religiosity, unemployment, immigration, consumption of alcoholic beverages, suicide, and strikes.[1] Dr. Berridge states that an "equally important feature, shown indirectly by an employment index, is the cycle of *social welfare*. Largely as the result of fluctuations in the economic prosperity of wage-earners, there are found to be pronounced cycles of suicide, crime, prostitution, pauperism, marriages, migration, and other social problems." [2] Much has been written upon the variations in the death-rate, marriage-rate and divorce-rate attendant upon crop failures, other internal disturbances and war.[3] Rarely, however, have these conclusions been reached after rigorous statistical analysis and careful comparison. Most of these comparisons have depended, primarily, upon graphic presentation. It is clear that if we are interested in the relationship between sociological

[1] "That conditions of economic distress directly affect marriage, birth, death, sickness, suicide, and so on, has been demonstrated by numerous studies. It is, however, difficult to ascertain those effects; often the statistical requirements necessary are too difficult to make the results of value as indices." Philip Klein, *Burden of Unemployment* (New York, 1923), p. 202.

[2] William A. Berridge, *Cycles of Unemployment*, Publications of the Pollak Foundation for Economic Research, No. Four (Boston, 1923), p. 4. On the cycles of pauperism and desertion, see Maurice B. Hexter, "Relief, Desertion, and the Business Cycle," *Quarterly Publication of the National Conference of Jewish Social Work* (New York, 1924), vol. I, No. 1, pp. 5–55. See also W. H. Beveridge, *Unemployment* (London, 1917), p. 44.

[3] Arthur Freiherr von Firks, *Bevölkerungslehre und Bevölkerungspolitik* (Leipsic, 1898), pp. 172–73.

variables and economic conditions, we should subject the former, so far as possible, to the refined analysis that is used by economists in growing numbers in their studies of economic situations. Economists have made exhaustive studies in the past two decades of speculative, productive, and fiscal aspects of the ebb and flow of business. Where social changes of this sort have been studied,[1] the data have usually been in annual form. This form has certain advantages and certain very obvious faults. The principal advantages are that a much longer series is available and the data appear much

[1] R. H. Hooker, "On the Correlation of the Marriage Rate with Foreign Trade," *Journal of the Royal Statistical Society*, vol. LXIV (1901), p. 485; George R. Davies, "Social Aspects of Business Cycles," *Quarterly Journal of the University of North Dakota*, vol. XII, No. 2 (January, 1922), pp. 108–21; Katherine E. Howland, "A Statistical Study of Poor Relief," *Journal of the American Statistical Association*, vol. XVIII (December, 1922), pp. 480–89; W. F. Ogburn and D. S. Thomas, "The Influence of Business Cycles on Certain Social Conditions," *Journal of the American Statistical Association*, vol. XVIII (September, 1922), p. 340; G. U. Yule, "On the Changes in the Marriage and Birth-Rates in England and Wales during the past Half-Century," *Journal of the Royal Statistical Society*, vol. LXIX (1906), pp. 88–132; Ethel M. Elderton, *England North of the Humber*, Report on the English Birth-Rate, Part I (London, 1914), diagram opposite page 12; August Meitzen, *History, Theory, and Technique of Statistics* (translated by R. P. Falkner), (Philadelphia, 1891), p. 138; E. Levasseur, *La Population Française* (Paris, 1889), vol. II, diagram opposite p. 12; Heinrich Rauchberg, *Die Bevölkerung Oesterreichs* (Vienna, 1895), diagram opposite p. 26, giving the fluctuations in births, deaths, and marriages, together with the price of various grains, and average wages for the years 1820–90; L. M. Moreau-Christophe, *Du Problème de la Misère et de la solution chez les peuples anciens et modernes* (Paris, 1851), vol. III, p. 222; G. v. Mayr, *Statistik der gerichtlichen Polizei in Königreiche Bayern* (Munich, 1867), p. 136, *et passim;* A. von Oettingen, *Die Moralstatistik in ihre Bedeutung für eine Socialethick* (Erlangen, 1862), p. 239; L. Fuld, *Der Einfluss der Lebensmittelpreise auf die Bewegung der strafbaren Handlungen* (Mainz, 1881), p. 193; W. Starke, *Verbrechen und Verbrecher in Preussen, 1854–78* (Berlin, 1884), p. 77, *et seq.*; A. Meyer, *Die Verbrechen in ihrem Zusammenhang mit dem Wirtschaftlichen und Sozialen Verhältnissen in Kanton Zurich* (Jena, 1895), p. 60, *et passim;* M. Tugan-Baranowsky, "Die Socialen Wirkungen der Handelskrisen in England," *Archiv für Sociale Gesetzgebung*, vol. XV, p. 36, *et seq.*; *ibid.*, *Studien zur Theorie und Geschichte der Handelskrisen in England* (Jena, 1901). G. Schnapper-Arndt, *Sozialstatistik* (Leipsic, 1908), p. 624, *et seq.*; Paul La-

smoother; the obvious disadvantage is that many delicate variations and adjustments[1] in these data are swamped. Since the data come in annual periods, it is not possible to study monthly or seasonal fluctuations; and it is plain that much interest and value attach to seasonal fluctuations in these occurrences.

In order that these fluctuations in human experience may be compared with the ebb and flow of business, they must be treated to a similar procedure. It is necessary, then, to isolate the effects of four somewhat dissimilar forces: (1) The Trend, (2) Seasonal Variation, (3) Cyclical Fluctuations, and (4) Fortuitous Influences. This study is, then, an attempt to see whether, in time series with a sociological content, it is possible to extract and segregate the results of diverse forces.[2] If so, some progress has been made in understanding a little better these complex human occurrences. In breaking up these sociological or biological time series we have used the method developed by Professor Warren M. Persons, and used by the Harvard Committee on Economic Research.[3]

This study is based upon the following five series: the Monthly Birth-Rate, the Monthly Stillbirth-Rate, the

fargue, "Die Kriminalität in Frankreich," in *Die neue Zeit* (1890), p. 120; Gustav Aschaffenburg, *Crime and Its Repression* (Boston, 1913), p. 112; F. S. Crum, "The Marriage Rate in Massachusetts," *Journal of the American Statistical Association*, vol. IV (December, 1895), pp. 322–39.

[1] Such as securing the coefficient of correlation for various months lag and lead.

[2] An interesting and brilliant attempt to analyze sociological data, of a somewhat different kind, has been made by that master analyst, Karl Pearson, in his *Chances of Death*, where he breaks up the compound d_x curve into five skew frequency curves. For a criticism of the result, see Raymond Pearl, *Biology of Death* (The 1920 Lowell Institute Lectures), (Philadelphia, 1922), pp. 94–101; also Arne Fisher, *Frequency Curves* (New York, 1922), pp. 90–92.

[3] For a description of the method, see *The Review of Economic Statistics*, Preliminary Volume, No. 1 (January and April, 1919), (Cambridge, 1919), pp. 3–205; also published as *Indices of General Business Conditions*, by Warren M. Persons (Cambridge, 1919); Warren M. Persons, "Correlation

Monthly Death-Rate, the Number of Marriages Monthly, and the Number of Divorce Cases Filed Monthly. The first four of these series pertain to the City of Boston; the last, to Suffolk County.[1]

The presentation of this study is divided into two parts. In Part One each of these variates, in turn, is discussed with particular reference to the long-time trend, and the seasonal fluctuations. The detailed consideration of the last item is reserved for Part Two, in which we bring together the discussion of all the cyclical fluctuations.[2]

of Time Series," *Journal of the American Statistical Association*, vol. XVIII (June, 1923), pp. 713–26. Only one minor change was made, namely, in the adjustment of the discrepancy in the Seasonal Variation. Dr. Persons utilizes a logarithmic adjustment while we use an arithmetic adjustment.

[1] Boston is situated in Suffolk County and forms 89.53 per cent of its population.

[2] An interesting attempt to arrive at a numerical expression of what he called "the social, moral, and economic situations of human society at certain periods in different countries" was made by Newman Spallart ("Mesure des variations de l'état économique et social des peuples," in the *Bulletin de l'Institut international de Statistique*, vol. II, p. 151), in 1887, at the First Congress of the International Statistical Institute. Under the group of moral phenomena were the following: marriage-rate, birth-rate, illegitimacy, suicides, and crime. See "Economic Barometers," *Studies and Reports*, Series N, No. 5, International Labour Office (Geneva, 1924), pp. 42–44.

CHAPTER II

THE BIRTH-RATE

A. The Trend

TABLE I presents the Monthly Live Birth-Rate in the City of Boston for the period January, 1900, through December, 1921.[1] These data are presented graphically in Chart 1. It is easy to notice that the highest Monthly Live Birth-Rate occurred in December, 1907, when it reached 31.70. August, 1900, is very close to this peak month with a rate of 31.55. Next follows March, 1907, with its rate of 31.43. The lowest month during these twenty-two years was June, 1919, when the rate was 20.90 per 1000 population; close by is January, of the same year, with its rate of 21.40. There is, therefore, a difference of 1080 births per 100,000 of population between the peak month and the lowest month. In other words, the lowest month during this span of years represents a decline of 34.07 per cent (over one third) compared with the highest month.

A glance at Chart 1 shows that there has been a steady decline in the Monthly Live Birth-Rate during the past twenty-two years. The straight line running through the plotted rates is the trend line, or the line of "best fit," which has been secured by the Method of Least Squares. It is readily recognized that for this span of years a straight line gives a good "fit."[2] The equation to the line

[1] Throughout this whole discussion Tables referring to Actual Data, Seasonal Fluctuations, and Cyclical Fluctuations are placed in the body of the Study. Other Tables, important for future students in this field, are placed in the Appendix.

[2] For birth-rates over a longer span of years a straight line will probably not suffice. Ogburn and Thomas, *loc. cit.*, p. 332, for a span of fifty years

is $y = -.0093x + 26.91$, the origin being January, 1911. The ordinate of trend[1] on January, 1900, was 28.2306 (the highest point) and the lowest point was 25.7847, in

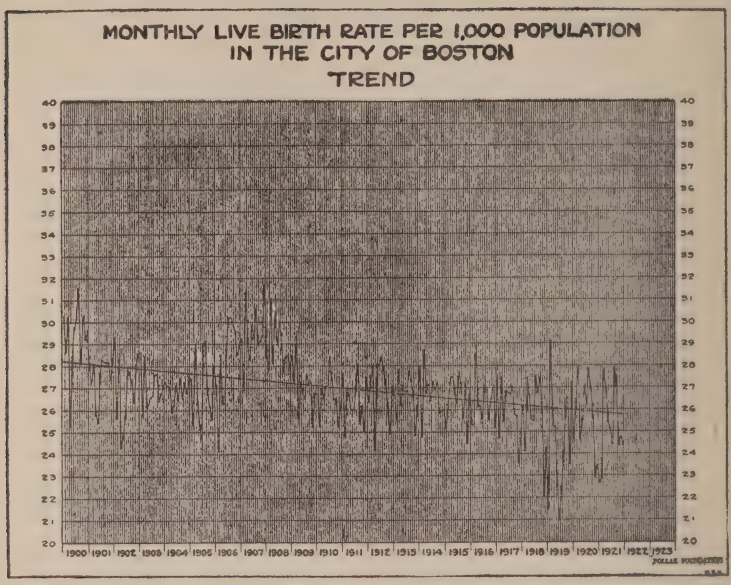

CHART 1

December, 1921. This is a difference of 2.4459, which represents a decline of 8.66 per cent during this span of years.

The declining birth-rate is not new in Massachusetts or in other parts of the United States. A glance at the chart of the General Birth-Rates for Massachusetts from 1850 to 1914[2] shows a definite downward trend, despite

use three parabolæ. On the other hand, Miss E. M. Elderton (*England North of the Humber*, Report on the English Birth-Rate, Part 1, Eugenics Laboratory Memoirs, XIX and XX, London, 1914), for a span of sixty years uses two straight lines.

[1] See Table No. 2 in Appendix.

[2] George Chandler Whipple, *Vital Statistics* (New York, 1919), p. 213;

TABLE 1. MONTHLY LIVE BIRTH-RATE PER 1000 POPULATION IN THE CITY OF BOSTON

YEAR	January	February	March	April	May	June	July	August	September	October	November	December
1900	30.27	28.60	30.27	25.30	28.64	29.71	30.03	31.55	28.10	30.30	29.20	29.60
1901	28.10	27.15	28.10	25.79	25.43	27.62	28.34	28.20	28.20	28.20	27.30	28.09
1902	29.34	25.63	28.40	24.30	24.91	25.72	28.02	27.68	27.30	26.32	28.09	28.53
1903	28.63	25.70	28.49	26.07	26.34	26.60	26.68	27.62	27.62	26.44	26.75	28.07
1904	27.30	27.10	27.10	25.88	26.28	27.18	26.41	27.43	26.50	27.30	26.74	27.33
1905	27.50	25.30	29.04	26.10	25.14	24.70	29.00	29.20	26.75	26.16	25.60	28.10
1906	27.12	24.10	28.57	26.35	26.30	29.20	30.30	30.30	29.90	29.64	28.50	28.81
1907	29.30	26.91	31.43	28.88	28.30	29.90	29.20	30.66	28.95	29.20	29.40	31.70
1908	28.43	27.68	31.10	28.11	30.40	28.95	30.07	28.70	27.76	28.48	28.50	27.90
1909	28.50	27.20	29.40	25.30	27.32	26.73	26.50	27.67	27.10	27.30	25.20	26.75
1910	26.70	25.20	27.00	26.53	27.08	27.08	28.41	27.30	26.50	26.62	25.19	26.17
1911	27.72	24.84	26.91	26.60	25.99	26.00	26.82	28.10	25.40	26.20	25.00	27.50
1912	26.30	27.60	28.00	24.20	28.10	28.00	28.40	27.90	27.30	26.14	24.92	27.14
1913	26.84	25.50	27.80	26.23	26.93	26.82	26.75	27.72	27.30	26.90	24.80	26.30
1914	28.02	24.70	28.70	26.68	27.21	26.40	27.33	26.97	27.33	25.80	26.00	26.12
1915	25.17	26.12	27.52	27.52	27.00	26.30	27.70	27.30	25.54	27.20	24.49	26.90
1916	25.30	25.30	28.90	26.10	26.20	25.60	27.14	26.85	25.51	26.49	27.10	25.14
1917	27.40	24.70	27.50	25.50	26.85	26.73	26.70	27.08	25.72	25.72	23.54	24.89
1918	26.15	24.10	27.40	26.50	25.57	25.47	27.60	26.70	27.48	25.64	22.04	24.32
1919	21.40	29.10	25.24	25.50	22.57	20.90	22.38	23.36	26.50	26.69	23.52	27.30
1920	24.66	26.29	27.98	24.42	25.52	27.12	26.21	27.85	26.75	25.62	22.84	23.89
1921	22.63	22.87	27.73	26.73	25.38	25.13	24.41	27.94	27.43	24.34	24.80	24.39

three distinct upward movements before 1900, namely, in 1856–59, 1871–74, and 1891–96. This declining birth-rate is found, too, for the United States as a whole. Professor Willcox [1] comes to the conclusion that we know practically nothing concerning the birth-rate in the United States. "But in default of this information," he says, "I have found an available substitute by comparing the number of children under five years of age at the date of each census with the number of women sixteen to forty-four years of age at the same census. The results are given in the following table, in which the figures before 1850 are estimated from such data regarding sex and age as the earlier censuses afford:

Date	Number of Children under 5 Years of Age to 1000 Women 16–44 Years of Age
1800	976
1810	976
1820	928
1830	877
1840	835
1850	699
1860	714
1870	649
1880	635
1890	554
1900	541
1910	508

During the sixty years, 1850–1910, the number of children to 1000 women of child-bearing age decreased in the United States by 191, or an average of 32 in each decade. There is only about seven tenths as large a

also, F. S. Crum, "The Birth-Rate in Massachusetts," *Quarterly Journal of Economics*, vol. XI (April, 1897), pp. 248–61.

[1] Walter F. Willcox, "The Nature and Significance of the Changes in the Birth and Death Rates in Recent Years," *Quarterly Publications of the American Statistical Association*, vol. XV (March, 1916), p. 11.

proportion of children in the United States now as there was in 1850."

In England the birth-rate has steadily declined since around 1877. Miss Ethel M. Elderton[1] concludes that "the first point which we think is definitely established in this paper is that there has been an immense fall in the birth-rate of England, north of the Humber, and this is true even when that rate is based solely on wives of the fertile ages, and when allowance is made by means of the potential birth-rate for the changing age of these wives." G. U. Yule[2] has gathered some interesting data for England and Wales. The following figures show the Annual Birth and Marriage Rates:

Period	Births per 1000 Living at all Ages	Persons Married per 1000 Living at all Ages
1851–1855	33.9	17.1
1856–1860	34.4	16.7
1861–1865	35.1	16.8
1866–1870	35.3	16.4
1871–1875	35.5	17.1
1876–1880	35.3	15.3
1881–1885	33.5	15.2
1886–1890	31.4	14.7
1891–1895	30.5	15.1
1896–1900	29.3	16.1
1901–1905	28.2	15.6
1906–1910	26.3	15.3
1911–1915	23.6	16.4
1916	20.9	14.9
1917	17.8	13.8
1918	17.7	15.3
1919	18.5	19.7

"It will be seen from the first column," says G. U. Yule, "that while in the quinquennium 1851–55 the

[1] Elderton, *op. cit.*, p. 232. See also, Sidney Webb, "The Decline of the Birth-Rate," *Fabian Tract No. 131* (London), 1909.

[2] G. Udny Yule, *The Fall of the Birth-Rate* (Cambridge, 1920), pp. 8–9.

births registered were in the proportion of 33.9 per 1000 of the population per annum, this figure rose to a maximum of 35.5 for the quinquennium 1871–75 and since then has fallen without a break, the average for 1906–10 being only 26.3 or rather over 25 per cent less than the biggest quinquennial average. The greatest figure touched in any individual year was 36.3 in 1876, while in 1911 it was only 24.4, a fall of roundly one third. To the rise previous to 1876 too much importance cannot be attached, as it is uncertain how far it may be due to increasing completeness of registration: it is with the fall I am mainly concerned. I have added to the quinquennial averages the figures for single years up to 1919, but later years are so largely affected by the special circumstances of the War that I propose to confine myself for the most part to the pre-War period ending with 1911 — the year of the last census." [1]

This decline in the birth-rate is a well-nigh universal phenomenon, at least so far as countries which maintain birth statistics with some accuracy are concerned. Note the data in the table on page 15.

It will readily be observed that the decline in the three decades fluctuates from thirty-four per cent in New Zealand to four per cent in Serbia. It is interesting in this connection to recall that the decline in the trend of the birth-rate in the City of Boston from 1900 through 1921 was 8.66 per cent.[2]

[1] G. U. Yule, *loc. cit.*, p. 11.

[2] Further valuable material on the question of the declining birth-rate will be found in the following: C. J. Lewis and J. N. Lewis, *Natality and Fecundity* (Edinburgh, 1906); A. Newsholme and T. H. C. Stevenson, "An Improved Method of Calculating Birth-Rates," *Journal of Hygiene* (April and July, 1905); A. Newsholme and T. H. C. Stevenson, "The Decline of Human Fertility in the United Kingdom and Other Countries as Shown by Corrected Birth-Rates," *Journal of the Royal Statistical Society*, vol. LXIX (1906), p. 34; D. Heron, "On the Relation of Fertility in Man to Social Status, etc.," *Drapers' Company Research Memoirs*, Dulau & Co. (1906); "The Declining Birth-Rate: Its Causes and Effects," in *Report of the Na-*

DECREASE IN THE BIRTH-RATE IN VARIOUS COUNTRIES
(Data from *Statistique Internationale*)

COUNTRY	AVERAGE ANNUAL BIRTHS PER 1000 AT ALL AGES		DECREASE PER CENT OF THE RATE IN 1901–10 ON 1871–80
	1871–80	1901–10	
England	35.4	27.2	23
Scotland	34.9	28.4	19
Ireland	26.5	23.3	12
Denmark	31.4	28.6	9
Norway	31.0	27.4	12
Sweden	30.5	25.8	15
Finland	37.0	31.2	16
Austria	39.0	34.7	11
Switzerland	30.7	26.9	12
German Empire	39.1	32.9	16
Netherlands	36.2	30.5	16
Belgium	32.3	26.1	19
France	25.4	20.6	19
Italy	36.9	32.7	11
Serbia	40.5	38.9	4
Australia	36.1	26.5	27
New Zealand	40.5	26.8	34

Before leaving the subject it will be interesting to see just what reasons have been assigned for this practically

tional Birth-Rate Commission (London, 1916); "The Fertility of Various Social Classes in England and Wales from the Middle of the Nineteenth Century to 1911," *Journal of the Royal Statistical Society* (April, 1920); R. R. Kuczynski, "Fecundity of the Native and Foreign-Born Population of Massachusetts," *Quarterly Journal of Economics*, vol. XVI, pp. 1–36; Dumont, "Essai sur le natalité en Massachusetts," *Journal de la Société Statistique de Paris*, t. XXXVIII (1897), pp. 332–53, 385–95; t. XXXIX (1898), pp. 64–69; Molinari, "Decline of the French Population," *Journal of the Royal Statistical Society*, vol. LIII, pp. 183–97; Paul Mombert, *Studien zur Bevölkerungsbewegung in Deutschland* (Karlsruhe, 1907), pp. 146–63; R. R. Kuczynski, *Zur Statistik der Fruchtbarkeit*, Jahrbucher für Nationaloekonomie und Statistik, III F., vol. XXXIII (1908), p. 229 *et seq.*; E. Levasseur, *op. cit.*, vol. II, p. 10.

universal fact. The reasons are diverse, and much work needs to be done before one may say definitely just what the causes are.

Herbert Spencer [1] postulates the fact that the various organs of a body compete for nourishment and growth and that only the surplus not needed by an individual for his own preservation is available for propagation; the nervous system of the body issues heavier draughts than does any other system; this same nervous system, as civilization proceeds, requires a larger and larger quantity, so that, as a net result, there is less and less available for purposes of procreation. Consequently, Spencer finds this physiological connection between civilization and a declining birth-rate. Willcox [2] does not believe that the supporters of the Spencerian view have maintained their position statistically. He says: "While admitting the heavy and increasing demands upon the nervous system made by modern conditions, I would point out that the decreased death-rate and the decrease of sickness by which it is probably attended mean an increase of human vitality and so of the surplus to be drawn upon. Whether the increased expenditure on the nervous system equals or exceeds this increased surplus no one has even tried to prove. Until that is done I believe the Spencerian theory must be deemed only a theory."

Francis A. Walker maintained that the decline in the birth-rate in America was due to the threat to American standards of living by the large number of immigrants who were accustomed to lower standards, and that this threat operated more strongly with reference to the native stock. In proof of his theory, President Walker held that

[1] *The First Principles of a New System of Philosophy* (Rev. Ed., London and New York, 1867), Section 72.

[2] Willcox, *loc. cit.*, pp. 12–13.

the decline of the birth-rate "among Americans began at the very time when foreign immigration first assumed considerable proportions; it showed itself first and in the highest degree in those regions, in those States, and in the very counties into which the foreigners most largely entered. It proceeded for a long time in such a way as absolutely to offset the foreign arrivals, so that in 1850, in spite of the incoming of two and a half millions of foreigners during thirty years, our population differed by less than ten thousand from the population which would have existed, according to the previous rate of increase, without reënforcement from abroad. These three facts . . . constitute a statistical demonstration such as is rarely attained in regard to the operation of any social or economic force." [1]

We have seen above, however, that Professor Willcox shows that this decline in the birth-rate began in the United States "as early as 1810, when immigration was an unimportant influence." [2] In addition, we have seen that this decline in the birth-rate is a world-wide phenomenon. It is no respecter of climate. It is found in countries of emigration, as well as in countries of immigration. It is found in countries with limited natural resources as well as in those with an abundance of unsettled land.[3]

[1] Francis A. Walker, *Discussions in Economics and Statistics* (New York, 1899), p. 441. See also *Reports of Immigration Commission* (Washington, 1908), vol. I, p. 494.

[2] Willcox, *loc. cit.*, p. 13. See also by the same writer "The Change in the Proportion of Children in the United States," *Quarterly Publications of the American Statistical Association*, vol. X (March, 1911).

[3] Allyn A. Young, "The Birth-Rate in New Hampshire," *Journal of the American Statistical Association*, vol. IX (1905), pp. 263–81. Professor Young there demonstrates that the birth-rate in New Hampshire definitely proved that so far as that State is concerned the enormous difference between the fecundity of the native and of the French-Canadian elements was due to social, not physiological, causes. J. A. Hill, "Comparative Fecundity of

A third explanation of the decline in the birth-rate is that "births and the birth-rate have come under the control of human will and choice in a sense and to a degree never before true." Miss Ethel M. Elderton states that "one of the most striking facts that emerged from a study of the birth curves was that the years 1875–77 very approximately marked the division between the periods of stability and of decline in the birth-rate. It is noteworthy that this epoch almost exactly fits the active propagandism for the limitation of families initiated by Mrs. Annie Besant and Mr. Charles Bradlaugh, which culminated in 1877 in the failure of the prosecution to convict them for publishing *The Fruits of Philosophy*. It would be absurd to suppose that either this teaching or the failure of the prosecution was the ultimate or sole source of the immense and rapid decline in our national birth-rate. But the admission of legality in the publication and in the propagandism which then resulted gave a simply overwhelming force to a movement which appealed largely to the needs of the better artisan and middle classes." [1] It is impossible to say to just what extent the growing knowledge of contraception is responsible for the decline, since, in the final analysis, the use of all such knowledge is a means and, probably, not a cause. Carr-Saunders [2] has shown in a most careful survey that certain of these modern

Women of Native and Foreign-Born Parentage in the United States," *Journal of the American Statistical Association*, vol. XIII (1913), pp. 583–604. On the relative birth-rates of native-born and foreign-born in the Birth Registration Area of the United States, see the admirable study by Raymond Pearl, "The Vitality of the Peoples of America," *American Journal of Hygiene*, vol. I, Nos. 5 and 6 (September–November, 1921), especially pp. 648–55. For further bibliography on differential fecundity, see Hornell N. Hart, "Differential Fecundity in Iowa," University of Iowa, *Studies in Child Welfare*, vol. II (1922), No. 2, pp. 37–39.

[1] *Op. cit.*, p. viii.

[2] A. M. Carr-Saunders, *The Population Problem* (Oxford, 1922), pp. 197–322.

methods have many ancient prototypes among people in all stages of cultural development, from the hunting and fishing races still in the Paleolithic age to the great populations of the ancient and modern world. Mr. G. U. Yule specifically states that "the recent fall in fertility has not been effected solely or mainly by the use of artificial methods of contraception. The only definite data we possess are against this view." [1]

Much work remains to be done before we can point definitely to the causes for the decline. The bald fact is that, more and more, married people desire fewer children. It is not unlikely, but this is still in the realm of theory, that these same married people want fewer children reared in a better manner.[2] If this is the case, the decline in the birth-rate is wholesome, because undoubtedly it is better for society to rear the same amount of progeny

[1] A. M. Carr-Saunders, *The Population Problem* (Oxford, 1922), p. 37.

[2] The hypothesis has been advanced that fertility is not a fixed quantity for a given group, but is subject to natural fluctuations. It is suggested that the "fluctuations are physiological in character, rhythmic variations in germinal vitality, analogous to those outbursts of vital energy which lead in the case of an infective organism to epidemics, in the case of higher forms of life to such phenomena as plagues of field mice, or plagues of locusts. On this hypothesis the birth-rate is not dependent in general on the immediate conditions which surround the organism, but upon the conditions which probably precede the period of high birth-rate and which are favorable to the storage of the specific energy." (G. U. Yule, quoting Dr. J. Brownlee on "Germinal Vitality," *Proceedings of the Philosophical Society*, Glasgow, 1908.) While the above is speculative, it offers, we believe, a field of work which might explain certain long-time fluctuations in birth-rates, at present unexplainable on any other ground. Closely related to this is the suggestion by Dr. A. Myerson (*American Review*, January–February, 1924) that, since "recent experiments show that diet can alter germplasm powers to the point of abolishing them . . . the lowered birth-rate which we are so fond of ascribing in the case of the upper social strata to their higher culture possibly depends in part on the change in their diet." In this connection see also Charles Edward Pell, *The Law of Births and Deaths* (London, 1921), who follows Thomas Doubleday's *True Law of Population* in stating that the differential birth-rate lies in over-nutrition of the upper and under-nutrition of the lower classes. See the interesting review of Yule's brochure in *American Statistical Association*, vol. XVII (June, 1921), p. 793.

with a low birth- and death-rate than with a high birth-rate and its usually accompanying high death-rate.

B. Seasonal Fluctuations

We turn next to a discussion of the influence of the seasons upon the birth-rate. We attempt to answer, here, the question in what degree the round of the seasons causes the birth-rate to fluctuate. Table 5 gives the seasonal fluctuations during the past twenty-two years. These fluctuations are shown graphically in Chart 2. It

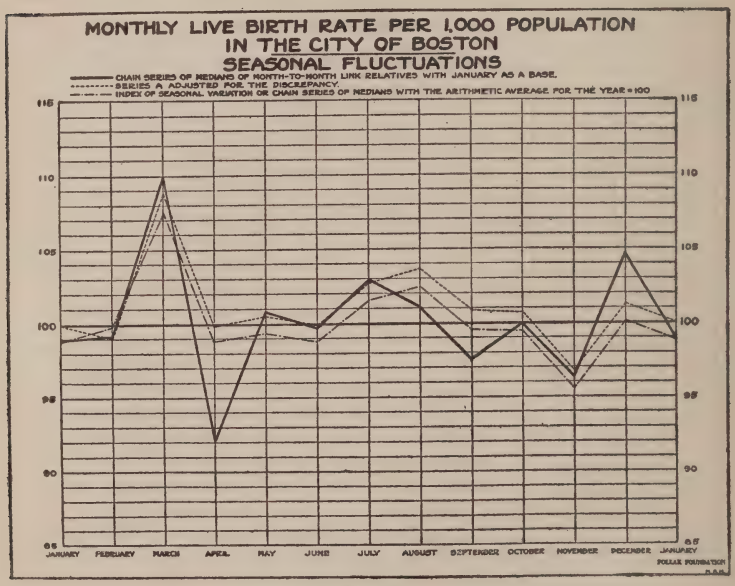

CHART 2

will be noticed that there is a distinct seasonal tendency. There are two pronounced maxima, in March and in August, and one distinct minimal point, in November. Quantitatively, March is represented by an index of 107.50, and August by an index of 102.44; November, the

Table 5. Seasonal Indexes, Monthly Live Birth-Rate

	Jan./Dec.	Feb./Jan.	March/Feb.	April/March	May/April	June/May	July/June	Aug./July	Sept./Aug.	Oct./Sept.	Nov./Oct.	Dec./Nov.	Jan./Dec.
Medians of Link Relatives.....	98.92	99.25	109.95	92.08	100.74	99.64	102.87	101.09	97.49	100.03	96.30	104.78	98.92
Chain Series	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.
With January as 100	100.00	99.25	109.13	100.49	101.23	100.87	103.76	104.89	102.26	102.29	98.51	103.22	102.11
Adjusted for Discrepancy.....	100.00	99.074	108.778	99.962	100.526	99.99	102.704	103.658	100.852	100.706	96.75	101.284	100.00
With Arithmetic Average as 100..	98.824	99.91	107.50	98.79	99.34	98.81	101.50	102.44	99.67	99.52	95.61	100.09	98.824

month with the lowest seasonal birth-rate, has an index of 95.61.[1] Many years ago, Wappäus[2] found that the birth-rate in Massachusetts presented two maximal points, namely, March and September.

Much evidence exists to show that the birth-rate is highly influenced by the seasons; that is, that there is a distinct pairing season, even among civilized men. Westermarck has summarized in excellent terms the existing evidence for seasonality.[3] "In the eighteenth century," he says, "Wargentin observed that in Sweden more children were born in one month than in another. The same has since been found to be the case in other European countries as well. According to Wappäus, the number of births in Sardinia, Belgium, Holland, and Sweden is subject to a regular increase twice a year, the maximum of the first increase occurring in February or March and that of the second in September and October. Sormani observed that in the south of Italy there is an increase only once a year, but more to the north twice, namely, in spring and in autumn. Mayr and Beukemann found in Germany two annual maxima — in February or March and in September; and Haycraft states that in the eight largest towns of Scotland more children are born in legitimate wedlock in April than in any other month. As a rule, according to Sormani, the first annual increase of births has its maximum in Sweden in March; in France and Holland, between February and March; in Belgium, Spain, Austria, and Italy, in February; in Greece, in January. Thus it comes earlier in Southern Europe than farther north. Again, the second annual increase is found

[1] The Standard Deviation of the Seasonal Fluctuations is 2.2874.

[2] J. E. Wappäus, *Allgemeine Bevölkerungsstatistik* (Leipsig, 1859–61), vol. I, p. 250; also G. v. Mayr, *Statistik und Gesellschaftslehre* (Freiburg, 1897), vol. II, p. 172.

[3] Edward Westermarck, *History of Human Marriage* (5th ed., London, 1921), vol. I, pp. 94–95.

more considerable the more to the north we go. In South Germany it is smaller than the first one, but in North Germany generally larger; and in Sweden it is decidedly larger."[1]

We may well question whether these seasonal variations in the birth-rate are not intimately connected with the seasonality of marriage. To answer this question we need to anticipate our analysis of the marriages in Suffolk County, which reveals a distinct seasonality. We have correlated the two seasonal fluctuations. The following are the coefficients[2] secured by allowing the seasonal index of the birth-rate to lag.

[1] In Preussen kommen die meisten ehelichen Geburten im Staate und auf dem platten Lande im September, die wenigsten hingegen im Juni vor. In den Grossstädten fält das Maximum in den Januar, das Minimum in den Mai, in den Mittel- und Kleinstädten das Maximum in den Februar und das Minimum in den Juni. Das Klima äussert hierbei auch bei der ländlichen Bevölkerung geringen Einfluss; denn sowohl in Ostpreussen wie im Rheinlande, in Schleisien wie in Schleswig-Holstein werden im September mehr eheliche Kinder auf dem platten Lande geboren als in jedem der drei vorhergegangenen oder nachfolgenden Monate. Die Sachsengängerei verschiebt in den davon betroffenen östlichen Provinzen Maximum und Minimum der Geburten (vgl. Zeitschr. des kgl. preuss. statist. Bureaus, 1885, S. 93 fg.) *Handwörterbuch der Staatswissenschaften* (Jena, 1909), vol. 4, pp. 530–31; also, G. v. Mayr, *Statistik und Gesellschaftslehre* (Freiburg, 1897), vol. II, pp. 169–75.

[2] "A coefficient of correlation measures the degree to which two variables are associated, taking the value + 1 when a deviation of one variable from its mean is always associated with a proportional deviation of the other in the same direction, decreasing as the intensity of the association decreases until for complete independence of the two variables it takes the value 0, and again increasing in numerical value but with a negative sign for increasing intensity of association where deviations of one variable in one direction are coupled with deviations of the other variable in the opposite direction. Thus the absolute magnitude of a coefficient of correlation measures the intensity of the association of two variables, while its sign indicates whether, as one variable changes, the average values of the other variable change in the same or in opposite directions. The possible range of values is from + 1 to − 1." John Rice Miner, "Suicide and Its Relation to Climatic and Other Factors," *American Journal of Hygiene* (Baltimore, 1922), p. 75.

"The significance of a correlation coefficient is always to be judged, in any particular case, by the magnitude of a constant associated with it called the probable error. A correlation coefficient may be regarded as certainly sig-

COEFFICIENTS OF CORRELATION BETWEEN SEASONAL FLUCTUATIONS IN THE BIRTH-RATE AND MARRIAGES

TIME OF CORRELATION	THE COEFFICIENT
The two curves synchronous	−.6281
Birth-rate lagging 1 month	−.0661
Birth-rate lagging 2 months	+.0882
Birth-rate lagging 3 months	−.1158
Birth-rate lagging 4 months	+.2020
Birth-rate lagging 5 months	−.2713
Birth-rate lagging 6 months	+.1629
Birth-rate lagging 7 months	−.3148
Birth-rate lagging 8 months	+.1305
Birth-rate lagging 9 months	+.7109
Birth-rate lagging 10 months	−.0096
Birth-rate lagging 11 months	+.1157

These coefficients are shown in Chart 3. It is clear that the maximum correlation is secured when the curves are paired so that the curve representing the birth-rate lags behind the marriage curve nine months.[1] We call atten-

nificant when it has a value of four or more times that of its probable error, which is always stated after the coefficient with a combined plus and minus sign between the two. The coefficient is probably significant when it has a value of not less than three times its probable error. By 'significant' in this connection is meant that the coefficient probably is not merely a random chance result." Raymond Pearl, *The Biology of Death* (Johns Hopkins University, Philadelphia, 1922), p. 169.

It has been suggested that the magnitude known as the Probable Error is inapplicable to coefficients of correlation of time series. We have not presented them in this study, although most of them have been calculated. On this point see the Presidential Address at the Eighty-Fifth Annual Meeting of the American Statistical Association, "Some Fundamental Concepts of Statistics," by Warren M. Persons. This is the first chapter in Number Six of the Pollak Publications, *The Problem of Business Forecasting*.

[1] Charlier gives a Table showing "Coefficients of Disturbancy" for various bio-statistical variables. Thus the coefficient for Marriages is 5.49 ±0.79 and for Births is 4.07 ±0.66. Charlier then states "that [the fact that] the Coefficient of Disturbancy for Marriages is not significantly larger than the Coefficient for Births indicates that *eventually* the same disturbing influences operate upon these two phenomena. This statement cannot be generalized." C. V. L. Charlier, *Die Grunzüge der Mathematischen Statistik* (Hamburg, 1920), p. 43. It is, of course, obvious that the validity of these coefficients of correlation between these monthly fluctuations depends upon the faithfulness with which the seasonal factor is reached by the method used. Furthermore, we must note that we have compressed a long span of months into twelve indexes.

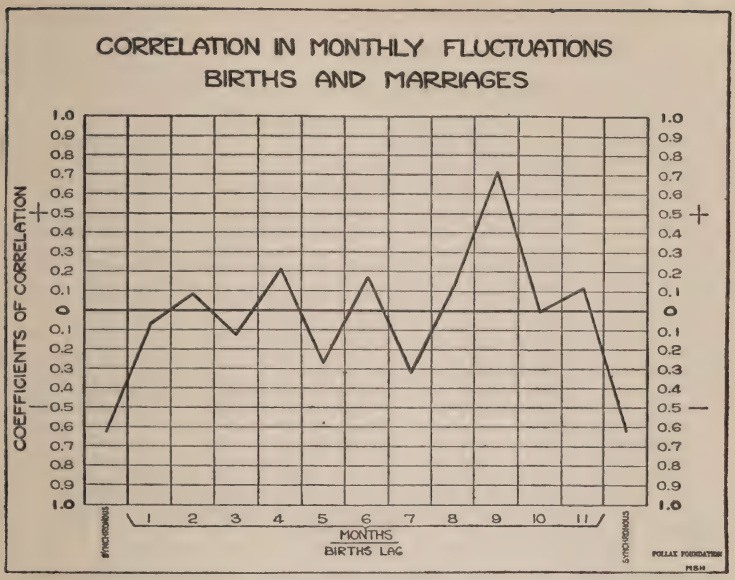

CHART 3

tion, too, to the high inverse correlation, −.6281, when the two curves are paired synchronously. The writer is unable at present to offer a reasonable interpretation of this high coefficient.[1] We must anticipate one conclusion of the study of Marriages in Suffolk County, namely, that seasonality in marriages after all reflects the pairing season because marriage is rooted in the family and not the family in marriage.

We turn next to another aspect of this seasonal fluctuation of the birth-rate — the question of the relationship

[1] One feature must, however, be borne in mind in interpreting coefficients resulting from correlating seasonal influences of the birth-rate and marriages: pairing the curves for various periods of lag or lead involves more than one month. Thus when we pair the two curves, January with January, what appears to be simultaneity may equally well involve a lag or lead of twelve months, twenty-four months, etc. The same applies to other degrees of pairing.

between the seasonal fluctuation in births and the seasonal fluctuation in unemployment. Although this study is primarily dedicated to the relationship between business cycles and these various sociological variables, we want, wherever possible, to study collateral relationships and influences. For the social scientist it is just as important to notice economic influences whether they arise from seasonal variations or from cyclical fluctuations. We have selected as indications of the seasonal variations in business the Adjusted Indexes of Seasonal Variation of Unemployment for Leading Trades in New York State.[1] Dr. Berridge has demonstrated the fact that the data from New York are highly representative of the whole country.[2] The following table shows the results of correlating these two seasonal curves; graphically the results are shown in Chart 4.

COEFFICIENTS OF CORRELATION BETWEEN SEASONAL FLUCTUATIONS IN THE BIRTH-RATE AND UNEMPLOYMENT

TIME OF CORRELATION	THE COEFFICIENT
The two curves synchronous	+.1967
The birth-rate lagging 1 month	+.3016
The birth-rate lagging 2 months	+.4408
The birth-rate lagging 3 months	+.3069
The birth-rate lagging 4 months	−.0545
The birth-rate lagging 5 months	−.0429
The birth-rate lagging 6 months	−.0004
The birth-rate lagging 7 months	+.1479
The birth-rate lagging 8 months	−.1082
The birth-rate lagging 9 months	−.3121
The birth-rate lagging 10 months	−.4749
The birth-rate lagging 11 months	−.3989

There are a number of interesting features disclosed by these coefficients of correlation. Notice, first, that the

[1] W. A. Berridge, "Unemployment and the Business Cycle," *Review of Economic Statistics*, Prel. Vol. IV, No. 1 (January, 1922), (Cambridge), p. 28. Also in Pollak Publication, Number Four.

[2] *Op. cit.*, p. 25.

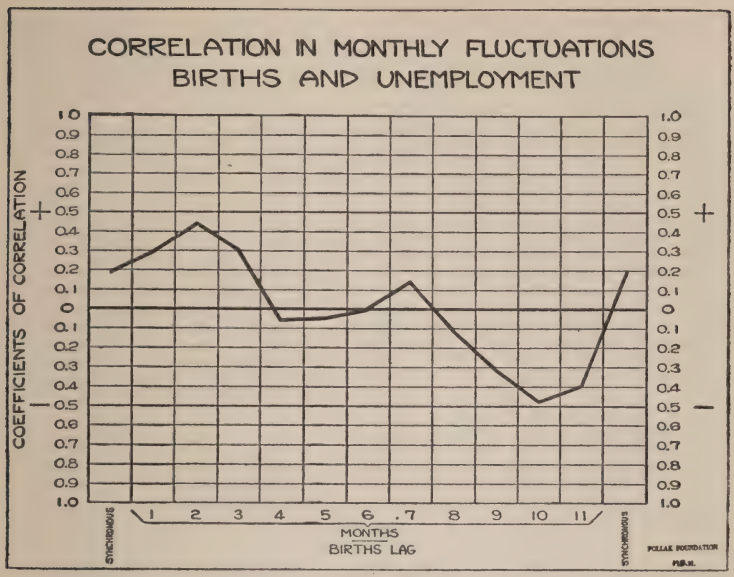

CHART 4

maximum is secured when the two series are paired in such a way that the birth-rate lags ten months. In that case the coefficient has the value of −.4749, which is considerable. This coefficient was secured by pairing the birth-rate with data for *unemployment;* we can, therefore, by reversing the sign of the coefficient (thus making it +.4749) speak of *employment.*[1] This coefficient says that after a lag of ten months in the seasonal fluctuation in the birth-rate, the greater the seasonal fluctuation in employment the greater the seasonality in the number of children born. Notice, further, that the coefficients are quite high and of the same sign for the period nine, ten, and eleven

[1] It is possible to reverse the sign in this manner, since an unemployment index reversed is an employment index; so that a negative correlation with unemployment is a positive correlation with employment.

months' lag.[1] In this connection notice that the coefficients for the period one, two, and three months' lag are likewise high, but in this case the sign is reversed. As we have mentioned above,[2] in correlating time series of seasonal fluctuations in which one of the variables is the birth-rate, we come closer to reality by viewing a direct pairing in time or a pairing for one month lag as constituting twelve and thirteen months' lag respectively. We would, naturally, not be justified in such an interpretation were we dealing with illegitimate births. While illegitimate births are included in our data, the proportion is too small sensibly to influence the phenomena under discussion.[3] With this explanation, notice the high positive correlation for the seasonal birth-rate lagging thirteen, fourteen, and fifteen months behind seasonal unemployment. We hazard the interpretation, then, that four, five, and six months following seasonality in unemployment more conceptions occur; or that fluctuations in employment are followed, with a lag of from four to six months, by fluctuations, opposite in character, of conceptions.

On the other hand, we have noticed that, for both curves, synchronous and for a period of lag of one and two months, just the reverse occurs in conceptions. The only reasonable explanation is that there are two general classes in the population. One is urged to prudence at the time of seasonal unemployment; the other is moved by no such consideration.[4] It should be clear, however, that the co-

[1] Note in this connection that the coefficient of partial correlation between employment and conception, with marriage constant, is zero. See the discussion of this point on page 74, below.

[2] See footnote 3, p. 7.

[3] George B. Mangold, *Children Born Out of Wedlock*, University of Missouri Studies, vol. III, No. 3 (June, 1921), pp. 15–27.

[4] Note, however, that there is no correlation of births and employment when marriage is held constant. See page 74, below.

efficient for one-month lag is higher than the one for two (or fourteen) months' lag.[1]

There is still another interesting feature about these coefficients of correlation to which we want to direct attention.[2] It has been shown that the maximum coefficient is secured with a ten-months lag in the birth-rate; previously we have demonstrated the fact that, when correlating the seasonality in marriages and seasonal fluctuations in the birth-rate, the highest coefficient is secured with a nine-months lag in the birth-rate. In other words, it requires one month more for seasonality in employment to make its influence felt than is sufficient for the influence of seasonality in the number of marriages. Several interesting interpretations of this fact suggest themselves, but we pass them by for lack of any corroborating evidence which we have been able to find.

C. Cyclical Fluctuations

We have discussed thus far the trend in the birth-rate and seasonal fluctuations. We turn now to a discussion of cyclical fluctuations.

The following two Tables — 7 and 8 — show the cyclical fluctuations in the birth-rate. These two Tables are shown graphically in Chart 5. The first outstanding feature to be noted is the irregularity of the fluctuations. For instance, in October, 1906, the Cycle Figure[3] stood at

[1] Were we to compute the probable errors of these two coefficients in the regular manner (the suggested impropriety of which we have mentioned above), we should find that the difference would be insignificant with regard to its Probable Error. As a matter of fact, the Probable Error is very likely indeterminate in the case of such small numbers, for here we are dealing with only twelve pairs.

[2] The correlation of the seasonality in birth-rates and death-rates will be discussed below in connection with Chapter IV.

[3] Professor Persons reserves the use of the term "Cycle Figure" for the item reached by dividing the difference secured by deducting the seasonal factor from the percentage deviation from the trend by the Standard Deviation.

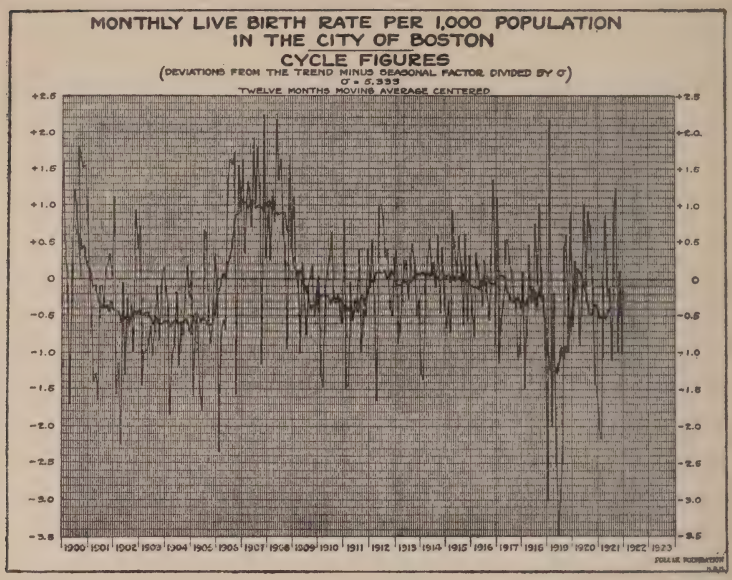

CHART 5

−.566 and jumped the next month +1.528. Fluctuations through such a wide amplitude in so brief a time period of one month are rare in economic statistics. We shall find this roughness in all the data analyzed. Possibly dealing with bi-monthly or quarterly data would provide smoother material, but interesting features of the analysis would be hidden.

The next outstanding feature which dominates the Chart is the tremendous fluctuations occurring in January, 1919 (−3.053), and in June, 1919 (−3.510).[1] The first item occurs nine to ten months after an exceptional fluctuation in the death-rate,[2] namely, February, 1918,

[1] Fluctuations of three times the Standard Deviation or more represent exceptional occurrences.

[2] See Chart 13. The Cycle Figure is almost three times the Standard Deviation.

Table 7. Cycle Figures, the Birth-Rate in the City of Boston

$\sigma = 5.333$

Year	January	February	March	April	May	June	July	August	September	October	November	December
1900	+1.575	+ .268	+ .058	−1.703	+ .420	+1.219	+ .953	+1.794	+ .024	+1.524	+1.532	+ .964
1901	+ .208	− .622	−1.406	−1.302	−1.646	− .098	− .097	− .360	+ .165	+ .201	+ .338	+ .032
1902	+1.114	−1.569	−1.131	−2.239	− .053	−1.298	− .255	− .634	− .364	− .986	+ .941	+ .403
1903	+ .714	−1.453	− .994	− .975	− .898	− .638	−1.063	− .600	− .072	− .834	+ .113	+ .160
1904	− .105	− .439	−1.856	−1.041	− .897	− .173	−1.172	− .653	− .758	− .182	+ .178	− .255
1905	+ .103	−1.584	− .467	− .819	−1.569	−1.781	+ .658	+ .624	− .514	− .881	− .523	+ .343
1906	− .079	−2.339	− .707	− .564	− .711	+1.354	+1.624	+1.545	+1.708	−1.566	+1.528	+ .905
1907	+1.594	+ .345	+1.328	+1.224	+ .713	+1.913	+ .955	+1.785	+1.140	−1.159	+2.224	+ .289
1908	+ .978	+ .259	+1.189	+ .776	+2.252	+1.344	+1.635	+ .602	+ .403	− .934	+1.688	+ .443
1909	+1.101	+ .006	+ .105	−1.007	+ .214	− .105	− .744	− .107	+ .025	+ .199	− .512	− .276
1910	+ .043	−1.301	−1.472	− .159	+ .126	+ .216	+ .654	− .283	− .313	− .197	− .449	− .602
1911	+ .810	−1.479	−1.451	− .036	− .555	− .274	− .369	+ .388	−1.003	− .411	− .511	+ .401
1912	− .083	+ .518	− .621	−1.648	+ .994	+1.011	+ .812	+ .293	+ .399	− .377	− .491	+ .229
1913	+ .371	− .874	− .679	− .149	+ .255	+ .264	− .270	+ .248	+ .480	+ .233	− .503	− .283
1914	+1.281	−1.361	+ .036	+ .255	+ .531	+ .049	+ .225	− .011	+ .581	− .463	+ .418	− .332
1915	− .649	− .285	− .713	+ .928	+ .463	+ .056	+ .568	+ .114	− .606	+ .606	− .576	+ .298
1916	− .463	− .789	+ .349	+ .002	− .013	− .362	+ .253	− .124	− .549	+ .182	+1.356	− .874
1917	+1.089	−1.140	− .563	− .347	+ .519	+ .521	+ .206	+ .122	− .323	− .289	−1.106	− .975
1918	+ .092	−1.494	− .549	+ .446	− .317	− .300	+ .746	− .068	+1.018	− .268	− .211	−1.022
1919	−3.053	+2.178	−2.018	− .191	−2.396	−3.510	−2.925	−2.391	+ .396	+ .568	− .977	+ .915
1920	− .636	+ .234	+ .037	− .893	− .195	+1.067	− .088	+ .909	+ .660	− .124	−1.395	−1.470
1921	−2.029	−2.162	− .056	+ .859	− .218	− .124	−1.125	+1.009	+1.238	− .973	+ .101	−1.031

TABLE 8. TWELVE-MONTHS MOVING AVERAGE OF CYCLE FIGURES, THE BIRTH-RATE IN THE CITY OF BOSTON

$\sigma = 5.333$

YEAR	January	February	March	April	May	June	July	August	September	October	November	December
1900						+ .719	+.605	+ .531	+.409	+.442	+ .270	+ .160
1901	+ .073	− .107	− .094	− .205	− .305	− .382	−.307	− .386	−.363	−.441	− .308	− .408
1902	− .430	− .449	− .489	− .595	− .537	− .506	−.539	− .530	−.518	−.413	− .483	− .428
1903	− .496	− .493	− .468	− .456	− .525	− .545	−.613	− .528	−.601	−.606	− .606	− .567
1904	− .576	− .581	− .638	− .584	− .578	− .613	−.595	− .691	−.575	−.557	− .613	− .747
1905	− .594	− .488	− .467	− .526	− .584	− .534	−.549	− .612	−.632	−.611	− .540	− .278
1906	− .198	− .121	+ .064	+ .007	+ .178	+ .225	+.364	+ .588	+.758	+.907	+1.025	−1.072
1907	+1.016	+1.036	+ .989	+1.023	+1.081	+1.029	+.978	+ .970	+.959	+.921	+1.050	+1.002
1908	+1.059	+ .960	+ .899	+ .918	+ .873	+ .886	+.897	+ .875	+.785	+.637	+ .467	+ .346
1909	+ .148	+ .089	+ .057	+ .152	− .032	− .092	−.180	− .289	−.420	−.358	− .357	− .330
1910	− .214	− .228	− .200	− .233	− .236	− .311	−.248	− .262	−.261	−.250	− .307	− .348
1911	− .433	− .377	− .435	− .453	− .458	− .374	−.449	− .282	−.213	−.347	− .218	− .111
1912	− .013	− .021	+ .096	+ .099	+ .101	+ .086	+.124	+ .008	+.003	+.128	+ .067	+ .004
1913	− .086	− .090	− .083	− .032	− .033	− .076	+.002	− .043	+.019	+.053	+ .076	+ .058
1914	+ .099	+ .078	+ .086	+ .028	+ .105	+ .101	−.060	+ .030	−.033	+.023	+ .018	+ .018
1915	+ .047	+ .057	− .042	+ .047	− .036	+ .017	+.033	− .010	+.079	+.002	− .039	− .073
1916	− .099	− .119	− .114	− .149	+ .012	− .086	+.043	+ .014	−.062	−.091	− .047	+ .027
1917	+ .023	+ .044	+ .062	+ .023	− .182	− .191	−.274	− .303	−.302	−.236	− .306	− .374
1918	− .329	− .345	− .233	− .231	− .157	− .161	−.423	− .117	−.240	−.293	− .466	− .734
1919	−1.039	−1.233	−1.262	−1.215	−1.279	−1.118	−.916	−1.078	−.906	−.965	− .781	− .400
1920	− .247	+ .111	+ .133	+ .076	+ .041	− .158	−.275	− .474	−.481	−.336	− .337	− .437
1921	− .523	− .515	− .466	− .537	− .413	− .376						

when a rigorous winter raised the mortality rate from respiratory diseases in Boston. The second tremendous fluctuation which we mentioned above — larger than the one just discussed — occurred in June, 1919. It will be recalled that in the fall of the preceding year the influenza epidemic raged in Boston. (See Chart 10, where it will be noted that in September and October of 1918 the Death-Rate stood, respectively, at the high level of 36.90 and 46.43.) The large fluctuation noted in the birth-rate for June of 1919 is, undoubtedly, the result of the epidemic which affected disproportionately females and "early adults." The Department of Preventive Medicine and Hygiene, Harvard Medical School, made an epidemiologic study of influenza. Concerning the disproportionate female incidence, the report says: "In comparing the sex incidence by age groups, we have found that females as a rule showed a slightly greater incidence than males. That this is not due fundamentally to occupational differences is suggested by a comparison of the sex incidence in the two epidemics studied." In 1918 the distribution is practically the same in the two sexes in all occupations except "Home," "Manual Outdoors," "Retail Sales Indoors," "Retail Sales Outdoors" (Chart 26). In the first the number of males is so small, and in the second and fourth the number of females is so small, that these cannot justly be compared. The group, "Retail Sales," consists in 1918–19 of 69 males and 27 females, out of a total distribution in the population of 426 males and 107 females. This is the only occupation that showed a definitely higher incidence among the females, and even here the number is too small for accuracy. In 1920 this difference practically disappeared.[1] Concerning the age

[1] Warren T. Vaughan, "Influenza; An Epidemiologic Study," *American Journal of Hygiene* (July, 1921, Baltimore), p. 155. See also Department of

distribution, the report quotes from the study by Doctors Frankel and Dublin who "in a study of 70,729 deaths from influenza-pneumonia among the policyholders of the Industrial Department of the Metropolitan Life Insurance Company, find that during the normal period between 1911 and 1917, influenza-pneumonia attacked primarily the first age period of life, ages one to four years, and the period of late middle life and old age. The rates are normally minimal between five and thirty years. In the last quarter of 1918, on the other hand, the highest rate among the whites is in the period of early adult life, between the ages of twenty-five and thirty-four. There appear three modal points instead of the two at the extremes. They find that the excess over normal was most marked in infancy and early childhood, and particularly in early adult life, culminating between the ages of twenty-five and thirty-four. The period of old age shows no significant *excess* during the period of the epidemic." [1]

It is interesting to refer to Chart 5, where it will be noted that there is reflected in the decline in the birth-rate in November and December, 1920, and in January and February, 1921, the recrudescence of the influenza epidemic of the preceding winter. Notice, too, that the decline in the birth-rate is much smaller and read in this connection the following from the Report mentioned above: "In general the 1920 recurrence was decidedly milder than the autumn outbreak of 1918." [2]

Commerce, United States Bureau of the Census, "Special Tables of Mortality from Influenza and Pneumonia" (1918), pp. 7–8, and Charts 19–24; also Lee K. Frankel and Louis I. Dublin, "Influenza Mortality among Wage-Earners and Their Families," *American Journal of Public Health*, vol. 9 (1919), pp. 731–42.

[1] Vaughan, *op. cit.*, p. 169.

[2] *Op. cit.*, p. 91. Dr. Milton J. Rosenau, Professor of Preventive Medicine and Hygiene, Harvard Medical School, says that pregnant women presented a disproportionately higher mortality.

We return, now, to Chart 5 and notice the rather smooth line running through the data. It represents the Twelve-Months Moving Average.[1] This line demonstrates clearly that there are Cyclical Fluctuations in the Birth-Rate and that they occurred during the twenty-two years under description. This curve further enables us to project a description of the cyclical fluctuations. We notice that the curve starts "above the line" in 1900, and just after the opening of the year 1901 "crosses the line," and remains around the amplitude of −0.5 until December, 1905, namely, for a period of five years. Then the curve begins to rise. It "crosses the line" in the spring of 1906; it continues to rise rather rapidly until it reaches the neighborhood of +1.15, where it remains for about eighteen months before it begins to swing downward. It "crosses the line" on this downward swing — after having been above the line for about three years, showing that this rise was through a greater amplitude, but for a briefer time — late in the spring of 1909 and fluctuates around −0.35 for about thirty-two months. Then it rises to the zero line and oscillates about it irregularly and mildly for about five and one-half years. Then, in April, 1917, the month in which the United States declared war,[2] the curve begins to show some activity. It drops for about sixteen months to the vicinity of −0.35, in the neighborhood of which it remains for about sixteen months. Then the curve drops still lower to about −1.25, whence it begins to rise gradually until it "crosses the line" very slightly in the spring of 1920 — just about nine months after many of the soldiers had been mustered out. Then

[1] It is assumed that items falling far beyond this line are the results of fortuitous circumstances — such as we have just mentioned with reference to the effect of the epidemic which is neither seasonal nor yet proved to be cyclical.

[2] For the influence of war upon births in France, see E. Levasseur, *op. cit.*, vol. II, pp. 168, 210.

the curve drops below the line in the summer of that year, and until the middle of the year 1921 fluctuates around the point −0.5. This is a brief description of the course of the cyclical fluctuations of the birth-rate from 1900 through 1921.[1]

D. Harmonic Analysis of the Birth-Rate

Chart 6 shows the results of applying the method of harmonic analysis[2] to the crude data for the birth-rate. The

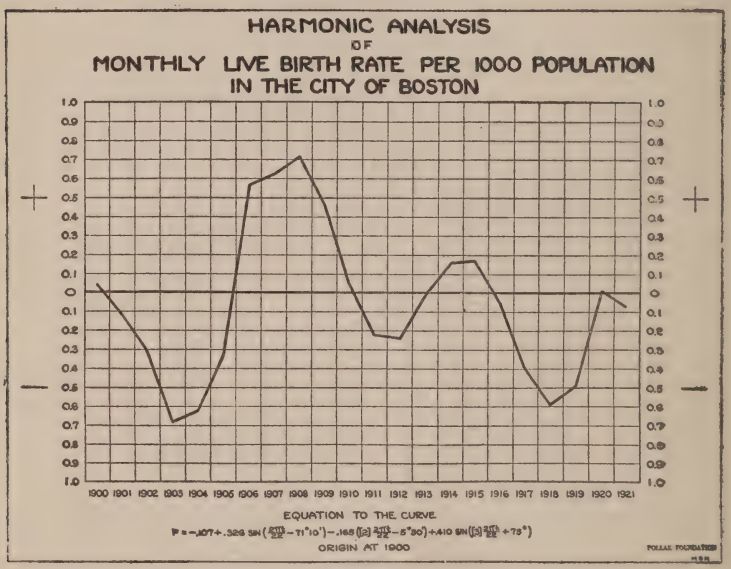

CHART 6

[1] The correlation of these fluctuations with variables representing the business cycle is given in Chapter VIII, below.

[2] This is the method utilized by Professor H. L. Moore, in *Economic Cycles, Their Law and Cause* (New York, 1914); see especially pp. 6–14; also Professor Moore's three articles in the *Quarterly Journal of Economics*, vols. 35 and 36; *ibid.*, *Generating Economic Cycles* (New York, 1923); see, too, a critical review of Professor Moore's methods by Mark H. Ingraham, in the *Journal of the American Statistical Association*, vol. XVIII (June, 1923), pp. 759–65; also by P. G. Wright, in the *Quarterly Journal of Economics*, vol. XXXVI (August, 1922), pp. 691–704, and in the *Journal of the American Statistical Association*, vol. XIX (March, 1924), pp. 103–08.

equation to the curve is stated in the Chart. By comparing this Chart with the Twelve-Months Moving Average on the preceding Chart, it will be noted that *in general* the two curves conform. There is the depression in the birth-rate from 1901 through 1905; then the curve is above the line for four and one-half years; then it is below the line for about three years, although the amplitude is less than the amplitudes of the two preceding loops. Then the curve is above the line for a little over two years; then, after the middle of 1916, the curve is below the line to 1921, and almost to the same depth as the depression from 1901 through 1905.

CHAPTER III

THE STILLBIRTH-RATE

A. The Trend

TABLE 11 presents the Monthly Stillbirth-Rate in the City of Boston per 1000 of the population for the period January, 1900, through December, 1921 — a span of twenty-two years. These actual rates are plotted on Chart 7. It will be noted that the month with the heaviest

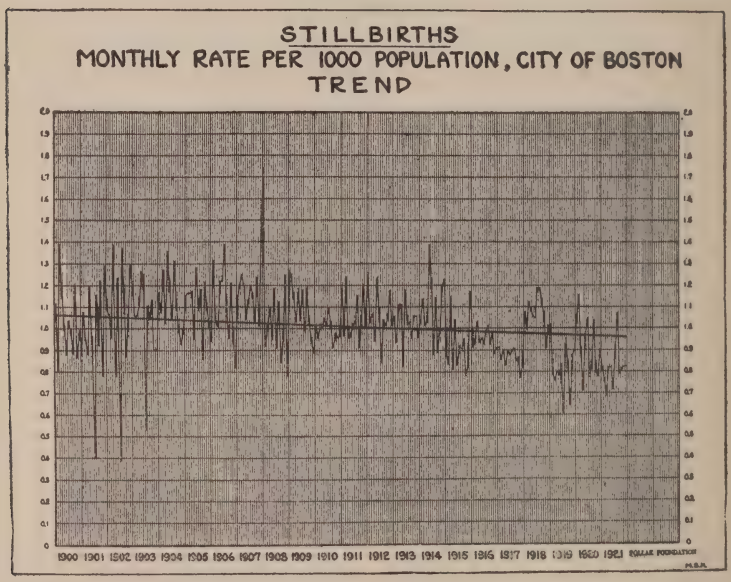

CHART 7

rate was January, 1908, when the figure was 1.74; the lowest rate was registered in July, 1902, when the figure recorded was 0.39. There is, then, a difference between the highest and the lowest month in this series of 135 still-

TABLE 11. MONTHLY STILLBIRTH-RATE PER 1000 POPULATION IN THE CITY OF BOSTON

YEAR	January	February	March	April	May	June	July	August	September	October	November	December
1900	1.12	.80	1.39	1.17	1.01	.88	1.04	.98	.89	1.21	.87	1.00
1901	.88	1.07	.96	.88	1.20	.95	.40	1.16	.93	1.22	.78	1.29
1902	1.08	1.06	.95	1.39	.78	1.24	.39	1.37	1.14	.87	1.04	1.30
1903	1.20	1.06	1.06	1.10	1.27	1.25	.53	1.11	1.04	1.13	.90	.90
1904	1.17	1.07	1.27	1.03	1.36	1.23	1.05	1.32	1.09	.99	.93	.99
1905	1.16	1.17	1.17	1.18	.95	1.28	1.08	1.18	.86	1.22	1.08	1.02
1906	.84	1.32	1.03	1.00	1.22	1.22	1.39	1.05	.96	1.21	.96	.82
1907	1.15	1.20	1.25	1.21	1.04	1.13	1.20	1.16	1.03	1.24	1.01	1.47
1908	1.74	.92	1.03	1.09	.95	1.19	.91	1.13	.84	.95	1.25	.78
1909	1.27	1.25	1.15	1.03	1.19	1.04	1.18	.98	1.20	1.02	.94	.89
1910	1.02	.96	1.02	1.00	1.05	1.02	1.10	1.03	.91	.98	.96	.97
1911	1.19	.97	1.24	.96	.97	1.03	1.00	1.15	.91	1.01	1.21	.91
1912	1.26	1.03	1.07	.94	1.24	1.07	.84	1.04	1.01	1.04	1.18	1.01
1913	1.06	.94	1.11	1.11	.83	1.18	1.01	1.03	.96	1.06	1.06	.96
1914	1.03	1.14	1.01	1.13	1.38	1.11	.88	1.14	.89	.99	1.20	1.23
1915	.88	.84	1.15	.81	1.04	.84	.93	.90	.96	.78	.83	1.17
1916	.91	.93	1.04	.94	.96	.93	.99	1.01	.93	.98	.88	.91
1917	.91	.85	.90	.83	.90	.88	.90	.91	.85	.87	.77	.83
1918	1.08	.99	1.13	1.08	1.05	1.04	1.19	1.19	1.13	1.05	.90	1.01
1919	1.02	.79	.76	.80	.78	.84	.60	.96	.85	.64	.87	.90
1920	1.05	1.16	.89	.71	.95	1.05	.78	.81	1.04	.80	.78	.90
1921	.82	.76	.68	.82	.82	.72	.90	1.07	.79	.81	.82	.82

births per 100,000 of the population. The range of fluctuation is therefore very high.

Despite the fact that some of the lowest rates recorded in the entire series of months precede in time some of the higher rates, the trend is definitely downward. This is shown in the heavy straight line in Chart 7. The equation to the line is $y = -.000387x + 1.015739$, the origin being January, 1911. The Ordinate of Trend at its highest point stood at 1.066629 in January, 1900; the lowest month, December, 1921, registered 0.964848. The decline, then, in the trend is 0.101781 or 9.54 per cent in the twenty-two years. This is slightly larger than the percentage decline in the birth-rate which we found to have been 8.66 per cent during exactly the same period. We are justified in stating that, in the past twenty-two years in Boston, the stillbirth-rate has declined a little over ten per cent more rapidly than the birth-rate.[1]

B. Seasonal Fluctuations in the Stillbirth-Rate

The question whether there is seasonality in the stillbirth-rate is an interesting one, because we are not dealing with a phenomenon which in seasonality is apt to present a fair degree of homogeneity. By definition "fœtal deaths which occur before the sixth or seventh month of gestation are known as miscarriages and are not reportable or recognized in ordinary statistical work; those which occur later than this are called stillbirths and must be reported." [2] It is manifest, therefore, that these deaths

[1] This decline was noted earlier by Professor Whipple. He points this out by analyzing both the stillbirth-rate per 1000 inhabitants and the stillbirth-rate per 100 living births. (Whipple, *op. cit.*, p. 340.) Also see G. v. Mayr, "Bewegung der Bevölkerung des Königreichs Bayern in Kalenderjahr 1876," in *Zeitschrift des Königliches Bayerischen Statistische Bureaus*, vol. x (1878), pp. 47–81; Arne Fisher, *The Mathematical Theory of Probabilities* (second edition, New York, 1923), vol. 1, pp. 154–55.

[2] Whipple, *op. cit.*, p. 340.

represent conceptions occurring in different months. This lack of homogeneity must be borne in mind throughout this whole discussion of the stillbirth-rate. Nevertheless, it is worth while seeing whether there is any seasonality, because the method of analysis used in this study permits the measurement of seasonality before its removal.[1] It is especially interesting because Professor Whipple states that "the monthly records show no appreciable variation in the rate of stillbirths during the year."[2] Table 15 shows the seasonal variation in the rate of stillbirths during the past twenty-two years. These data are shown in Chart 8. It is obvious from even a cursory

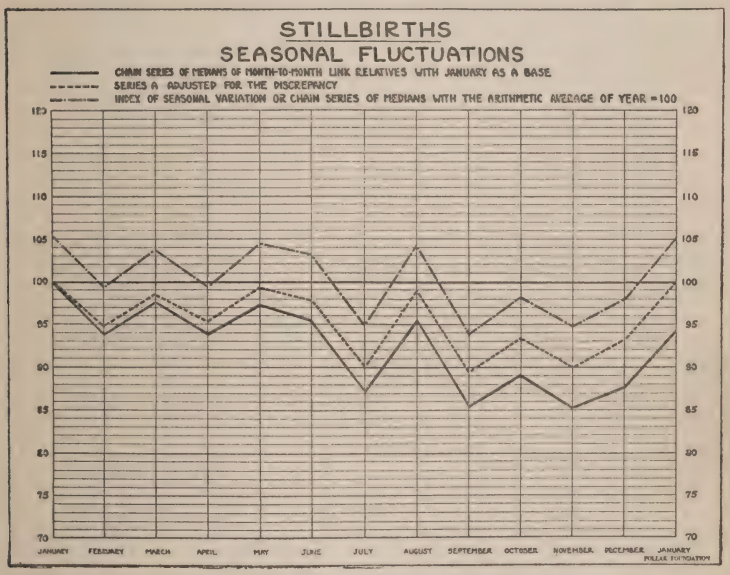

CHART 8

[1] This is one of the great virtues of Professor Persons's method, since seasonality in sociological phenomena is of vital importance. Other methods of analysis of time series frequently remove the influence of the seasons without first measuring it.

[2] Whipple, *op. cit.*, p. 341; see, however, G. v. Mayr, *Statistik and Gesellschaftslehre* (Tübingen, 1917), vol. III, pp. 99–100.

TABLE 15. SEASONAL INDEXES, MONTHLY STILLBIRTH-RATE

	Jan./Dec.	Feb./Jan.	March/Feb.	April/March	May/April	June/May	July/June	Aug./July	Sept./Aug.	Oct./Sept.	Nov./Oct.	Dec./Nov.	Jan./Dec.
Medians of Link Relatives.....	107.333	93.799	104.064	96.225	103.604	98.138	91.375	109.466	89.038	104.213	95.756	102.994	107.333
Chain Series	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.
With January as 100..	100.000	93.799	97.611	93.926	97.311	95.499	87.262	95.522	85.407	89.005	85.228	87.780	94.217
Adjusted for Discrepancy.....	100.000	94.281	98.575	95.372	99.239	97.909	90.153	98.895	89.262	93.342	90.047	93.081	100.000
With Arithmetic Average as 100.....	105.341	99.317	103.840	99.413	104.540	103.138	94.968	104.177	94.030	98.328	94.857	98.053	105.341

comparison that the seasonal influence is not so marked as it was in the case of the live birth-rate. There, it will be recalled, there were two maximal points and one minimal; here, while we note a number of months which are high and a number of months which are low, it is difficult to postulate much *seasonality* because in but one instance is there any succession of either low or high points. Note how the high points alternate, with but one exception, with the low points from January to September. From September through the month of December the seasonal factor is noted.[1] The Indexes for the months of September, October, November, and December are, respectively, 94.030, 98.328, 94.857 and 98.053. We are warranted in stating that while there is not a notable seasonality in the stillbirth-rate, nevertheless the fall months are lower on the average than other months of the year.

C. Cyclical Fluctuations

Tables 17 and 18 show the cyclical fluctuations in the stillbirth-rate. The data of these two Tables have been plotted on Chart 9. In the Chart, the heavier, smoother line represents the Twelve-Months Moving Average. As in Chart 5, where the cyclical fluctuations in the monthly live birth-rate were exhibited, we notice here irregularity in the actual Cycle Figures. For instance, July, 1902, has a Cycle Figure of −3.650, while August, in the same year, experienced a Cycle Figure of +0.990, which represents an amplitude of over four and one-half times the Standard Deviation through which the Cycle Figures ranged in two months.

The next outstanding features are the three periods in this span of months in which very wide fluctuations occur, namely, the summers of 1901 and 1902, January, 1908,

[1] The Standard Deviation of the Seasonal Index is 3.8302.

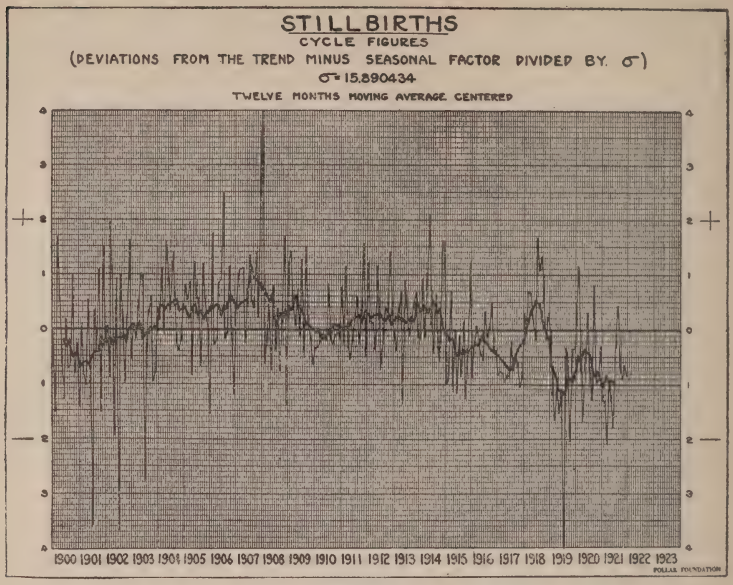

CHART 9

and June, 1919. We have mentioned the fact that fluctuations three times the Standard Deviation or more are rare: when they do happen they represent exceptional occurrences. During two of these periods we have just mentioned, the Cycle Figure was at four times the Standard Deviation; while during the other period it was over 3.5 the Standard Deviation. We have no explanation to offer for two of these three very wide fluctuations. The last one, however, namely, the one happening in June, 1919, is undoubtedly connected with the influenza epidemic in the fall of the preceding year. We have earlier mentioned [1] the connection between morbidity, mortality, and sex during the influenza epidemic.

The smooth line in the Chart represents the Twelve-

[1] See *supra*, p. 34.

TABLE 17. CYCLE FIGURES, MONTHLY STILLBIRTH-RATE PER 1000 POPULATION IN THE CITY OF BOSTON

$\sigma = 15.890434$

YEAR	January	February	March	April	May	June	July	August	September	October	November	December
1900	− .021	−1.528	+1.672	+ .654	− .611	−1.289	+ .173	− .759	− .651	+9.74	− .818	− .247
1901	−1.414	+ .093	− .842	−1.036	+ .543	− .851	−3.600	+ .336	− .390	+1.065	+1.519	+1.505
1902	− .201	+ .066	− .876	+2.026	−1.930	+ .903	−3.650	+ .990	+ .384	− .993	+ .243	+1.598
1903	− .544	+ .089	− .193	+ .327	+1.025	+ .996	−2.801	+ .097	+ .318	+ .590	− .946	− .768
1904	+ .396	+ .177	+1.097	− .065	+1.599	+ .909	+3.42	+1.391	+ .647	− .224	− .364	− .202
1905	+ .367	+ .809	+ .527	+ .869	− .841	+1.244	+ .552	+ .579	− .715	+1.195	+ .569	+ .007
1906	−1.540	+1.750	− .290	− .191	+ .823	+ .914	+2.463	− .178	− .084	+1.167	− .132	−1.182
1907	+ .369	+1.049	+ .078	+1.116	− .240	+ .399	+1.343	+ .522	+ .369	+1.384	+ .200	+2.812
1908	+4.051	− .624	− .234	+ .414	− .763	+ .797	− .401	+ .370	− .768	+ .361	+1.701	−1.383
1909	+1.169	+1.429	+ .532	+ .076	+ .740	− .092	+1.286	− .522	+1.474	+ .097	− .175	− .683
1910	− .337	− .326	− .238	− .081	− .093	− .187	+ .824	− .185	− .287	− .122	− .025	− .162
1911	+ .745	− .237	+1.155	− .300	− .559	− .096	+ .235	+ .589	− .262	+ .092	+1.557	− .508
1912	+1.215	+ .164	+ .131	− .398	+1.152	+ .183	− .735	− .064	+ .388	+ .309	+1.405	+ .143
1913	.000	− .369	+ .412	+ .694	−1.380	+ .903	+ .355	− .097	+ .105	+ .464	+1.685	− .141
1914	− .158	+ .915	− .185	+ .852	+2.105	+ .497	− .435	+ .626	− .308	− .575	+1.599	+1.590
1915	−1.011	− .946	+ .730	−1.137	− .004	−1.178	− .092	− .859	+ .161	−1.247	− .744	+1.246
1916	− .858	− .350	+ .066	− .288	− .481	− .581	+ .317	− .133	− .001	+ .490	− .367	− .375
1917	− .831	− .769	− .796	− .962	− .835	− .873	− .229	− .742	− .485	− .625	−1.044	− .859
1918	+ .285	+ .090	+ .705	+ .666	+ .160	− .180	+1.660	+1.083	+1.339	+ .558	− .185	+ .323
1919	− .068	−1.167	−1.642	−1.104	−1.554	−1.077	−3.996	− .364	− .433	−2.057	− .351	− .356
1920	+ .157	+1.237	− .778	−1.662	− .429	+ .309	− .923	−1.307	+ .825	− .999	− .908	− .329
1921	−1.304	−1.313	−2.115	− .925	−1.245	−1.805	− .118	+ .412	− .771	− .909	− .623	− .822

TABLE 18. TWELVE-MONTHS MOVING AVERAGE, MONTHLY STILLBIRTH-RATE PER 1000 POPULATION IN THE CITY OF BOSTON

YEAR	January	February	March	April	May	June	July	August	September	October	November	December
1900						− .196	− .321	− .185	− .395	− .535	− .439	− .404
1901	− .718	− .626	− .605	− .597	− .655	− .510	− .408	− .410	− .413	− .157	− .363	− .209
1902	− .222	− .167	− .103	− .275	− .128	− .120	− .149	− .147	− .089	− .231	+ .015	+ .027
1903	+ .093	+ .019	+ .013	+ .145	+ .046	− .151	− .073	− .065	+ .042	+ .009	+ .057	+ .052
1904	+ .312	+ .420	+ .446	+ .380	+ .427	+ .475	+ .473	+ .525	+ .473	+ .550	+ .352	+ .380
1905	+ .398	+ .330	+ .217	+ .335	+ .413	+4.30	+ .271	+ .350	+ .281	+ .193	+ .332	+ .304
1906	+ .464	+ .400	+ .453	+ .450	+ .392	+2.93	+ .453	+ .393	+ .507	+ .616	+ .528	+ .485
1907	+ .392	+ .450	+ .488	+ .507	+ .534	+8.68	+1.171	+1.031	+ .924	+ .866	+ .824	+ .854
1908	+ .710	+ .698	+ .602	+ .518	+ .643	+ .293	+ .053	+ .224	+ .287	+ .260	+ .386	+ .311
1909	+ .452	+ .377	+ .565	+ .642	+ .386	+ .443	+ .318	+ .173	+ .108	+ .095	+ .025	+ .018
1910	− .019	+ .007	− .139	− .157	− .145	− .101	− .011	− .004	+ .111	+ .094	+ .055	+ .062
1911	+ .013	+ .078	+ .080	+ .099	+ .229	+ .201	+ .240	+ .273	+ .187	+ .180	+ .323	+ .348
1912	+ .265	+ .210	+ .261	+ .283	+ .270	+ .325	+ .225	+ .178	+ .202	+ .298	+ .082	+ .142
1913	+ .233	+ .230	+ .207	+ .219	+ .159	+ .136	+ .122	+ .229	+ .180	+ .192	+ .484	+ .449
1914	+ .383	+ .444	+ .410	+ .323	+ .399	+ .544	+ .473	+ .317	+ .393	+ .227	+ .053	− .087
1915	− .059	− .183	− .143	− .199	− .394	− .423	− .410	− .360	− .416	− .345	− .385	− .335
1916	− .301	− .241	− .255	− .109	− .078	− .213	− .211	− .246	− .317	− .373	− .403	− .427
1917	− .473	− .224	− .565	− .657	− .714	− .755	− .661	− .590	− .465	− .329	− .246	− .187
1918	− .031	+ .121	+ .273	+ .372	+ .444	+ .542	+ .513	+ .408	+ .212	+ .064	− .078	− .152
1919	− .623	− .744	− .892	−1.111	−1.121	−1.180	−1.163	− .962	− .888	− .938	− .842	− .726
1920	− .471	− .550	− .444	− .356	− .403	− .400	− .523	− .735	− .848	− .784	− .855	−1.030
1921	− .963	− .819	− .953	− .945	− .922	− .962						

Months Moving Average. The first feature of this line to be noted is that up to the close of the year 1914 the duration of the waves is rather long; thenceforward, the waves are of a shorter duration. The course of the stillbirth-rate for the past twenty-two years is about as follows. The rate is below the line from 1900 through the first few months of 1903, when it oscillates around the zero line for a few months before it begins to rise quite definitely. The stillbirth-rate remains above the line to the close of the year 1909. Then the curve dips below the line for a very few months and immediately recrosses the zero line and remains slightly above it through the years 1910, 1911, 1912, 1913, and 1914. Then the rate drops below the line for the two years 1915 and 1916, and late in 1917 the curve begins a definite upward swing. It crosses the line on this upward swing in February, 1918. For the space of about ten months it remains there, but begins a sharp and pronounced downward swing. It crosses the line in November, 1918, and continues rapidly on its downward course until June, 1919, when the figure registered is −1.180; then the curve bends upward, but does not cross the line; the maximum of this upward movement is reached in April, 1920, when the line again bends downward and remains below the line throughout the rest of our series. This comprises a brief description of the course of the cyclical fluctuations in the stillbirth-rate from 1900 through 1921.[1]

[1] The correlation of these fluctuations with those of a variable representing the business cycle is given in Chapter VIII, below.

CHAPTER IV

THE DEATH-RATE

A. The Trend

TABLE 21 presents the death-rate in Boston, month by month, from January, 1900, through December, 1921. These data are plotted in Chart 10. The first feature

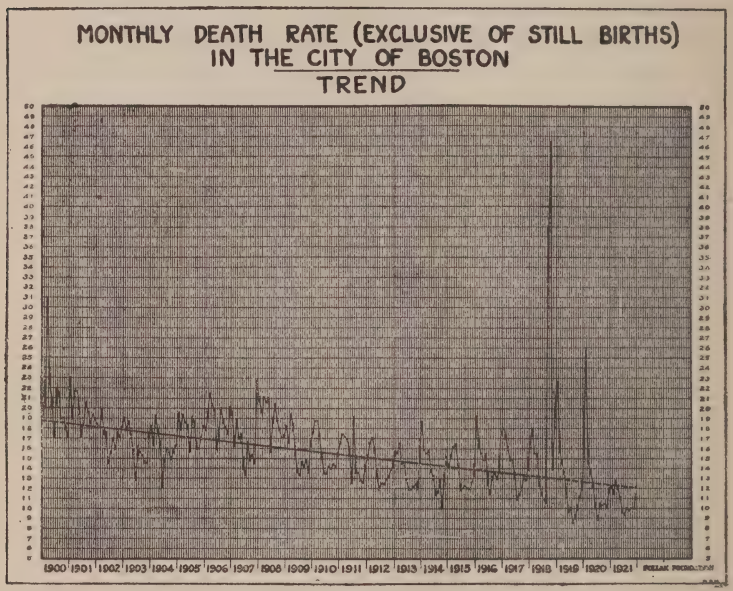

CHART 10

which strikes one is the tremendous peak in October, 1918, which dominates the whole series. It is the tragic month of the influenza epidemic. The rate registered that month was 46.43. The recrudescence of the epidemic is shown on the Chart by the smaller peak in February,

TABLE 21. MONTHLY DEATH-RATE (EXCLUSIVE OF STILLBIRTHS) IN THE CITY OF BOSTON

YEAR	January	February,	March	April	May	June	July	August	September	October	November	December
1900	21.64	20.17	31.00	22.63	20.43	16.99	21.91	21.37	18.89	19.08	17.95	17.10
1901	23.04	19.88	21.95	21.44	19.87	17.09	18.70	20.69	19.48	18.37	19.43	18.89
1902	18.34	18.05	19.84	17.30	17.71	14.54	15.61	17.04	15.92	17.75	17.09	18.03
1903	19.10	17.75	18.81	17.37	15.72	12.75	16.23	15.61	15.24	14.54	14.58	17.34
1904	18.34	16.23	19.30	17.66	16.24	12.06	14.85	16.02	15.70	14.85	15.71	16.25
1905	19.60	17.80	19.37	18.47	18.25	15.56	19.25	18.66	15.96	15.98	17.17	18.38
1906	17.79	19.03	21.50	20.26	20.01	15.91	17.73	20.19	18.52	18.04	17.30	20.15
1907	19.70	16.15	18.95	16.85	17.50	14.02	13.04	16.70	14.65	15.45	14.38	22.90
1908	20.64	19.23	21.10	20.57	21.08	15.54	18.71	20.44	18.55	17.79	16.98	17.21
1909	18.32	16.50	19.50	18.34	15.51	13.67	13.14	14.76	14.06	14.88	13.57	16.93
1910	17.55	18.79	18.79	17.23	14.80	13.42	13.42	14.24	13.93	14.52	14.03	15.50
1911	16.25	17.41	17.11	16.78	16.08	12.52	19.26	13.51	13.63	12.73	12.40	14.36
1912	15.10	16.52	17.07	15.93	13.31	11.90	12.57	12.38	12.83	13.16	13.86	14.31
1913	15.75	15.49	16.54	14.51	14.83	12.69	11.88	11.94	12.19	12.52	11.83	16.09
1914	18.70	15.96	15.52	15.92	13.66	13.15	11.28	11.59	12.89	10.03	13.27	15.28
1915	14.26	15.45	16.15	16.51	14.12	11.81	12.07	12.24	12.04	11.98	12.63	13.20
1916	19.32	16.11	15.59	14.90	15.46	12.26	11.38	13.07	13.59	12.88	13.59	17.61
1917	18.10	17.60	15.93	14.76	14.80	13.26	10.80	11.31	11.87	13.15	12.86	14.09
1918	16.50	18.07	15.40	15.48	12.36	11.23	10.72	10.36	36.90	46.43	13.87	20.16
1919	22.65	15.73	14.43	13.51	11.81	9.62	10.06	8.50	9.16	10.01	11.21	13.12
1920	16.32	26.03	14.67	13.62	12.57	10.29	8.83	10.46	10.25	10.57	10.01	11.97
1921	12.33	11.41	12.87	11.86	11.01	9.59	9.41	10.08	9.77	10.14	10.04	11.48
1922	14.04	14.87										

1920, when the death-rate stood at 26.03. If we omit the four years, 1918–21, years which contained such disturbing influences, we find that the highest death-rate occurred in March, 1900, when a rate of 31.00 was registered; the lowest month was October, 1914, with a rate of 10.03. In other words, a comparison of the lowest and the highest monthly death-rate shows a decline of 67.65 per cent, compared with a decline in the birth-rate from the highest month to the lowest month of 34.07 per cent. It would seem that the fluctuation in the monthly death-rate ranges over wider amplitudes.[1]

A glance at Chart 10 shows that there has been, except during the influenza months, a steady decline in the death-rate during the past twenty-two years. The straight line running through the plotted data is the trend line secured without reference to the four years, 1918–21. For those years the trend has been extrapolated. In the Chart this is shown by the broken portion. For the span of months under survey it will be noted that a straight line gives a good "fit."[2] The equation to the line is $y = 16.0324 - .026446x$. The highest point on the trend line is 19.047 in January, 1900; the lowest point, December, 1921, is 12.092. This represents a decline in trend of 36.51 per cent in these twenty-two years. This must be compared with a decline of 8.66 per cent in the monthly birth-rate during a similar span of months. In other

[1] Charlier's "Coefficient of Disturbancy" for deaths in various years is much larger (6.99 ± 0.92) than the same magnitude for births (4.07 ± 0.66).

[2] For this span of years a straight line will "fit" even death-rates for specific diseases or groups of diseases. See Raymond Pearl, *Biology of Death* (Philadelphia, 1922), pp. 230–37, where the rates for the following diseases and groups of diseases are presented: Tuberculosis, Typhoid Fever, Diphtheria and Croup, Dysentery, Bronchitis (acute and chronic), Paralysis without specific cause, Purulent Infection and Septicemia, Softening of the Brain.

words, the death-rate has declined much more rapidly than has the birth-rate.[1]

This decline in the death-rate is not new to Massachusetts. It was noted earlier by Professor Willcox.[2] The following figures show the death-rate in Massachusetts by decades:

Decade	Death-Rate in Massachusetts
1850–59	18.0
1860–69	19.4
1870–79	19.7
1880–89	18.6
1890–99	19.1
1900–09	16.0
1910–19	15.36

It will be noted that the death-rate rose until 1880 and has been falling substantially and fairly steadily ever since. Other portions of the United States, with but a few minor exceptions, show similar fluctuations. The following Table shows the course of the death-rate in the Registration Area in the United States since 1900.[3]

Death-Rates for the Registration Area of the United States, 1900–21

Year	Deaths per 1000 Persons	Year	Deaths per 1000 Persons
1900	17.6	1903	16.0
1901	16.5	1904	16.5
1902	15.9	1905	16.0

[1] Professor Pearl has defined a magnitude called "The Vital Index" which is the number of deaths divided by the number of births. It is plain that when this magnitude is less than 100, the births exceed deaths; when the percentage is greater than 100, the deaths are more frequent than births. Using the ordinates of trend in such a computation, we find the Vital Index in January, 1900, to be 67.47; in December, 1921, it had declined to 46.90, showing in another manner that the death-rate is declining more rapidly than the birth-rate.

[2] *Loc. cit.*, p. 2. Except the last item, the data are excerpted from that article.

[3] I. S. Falk, *Principles of Vital Statistics* (Philadelphia, 1923), p. 159.

Year	Deaths per 1000 Persons	Year	Deaths per 1000 Persons
1906	15.7	1914	13.6
1907	16.0	1915	13.6
1908	14.8	1916	14.0
1909	14.4	1917	14.3
1910	15.0	1918	18.1
1911	14.2	1919	12.9
1912	13.9	1920	13.1
1913	14.1	1921	11.6

This decline in the death-rate is not confined to America. It is, as we found to be the case with the birth-rate, practically a universal phenomenon. The decline in England, for example, is shown in the following data:[1]

Death-Rate in England and Wales

Period	Deaths per 1000 Living at all Ages	Period	Deaths per 1000 Living at all Ages
1851–1855	22.7	1896–1900	17.7
1856–1860	21.8	1901–1905	16.0
1861–1865	22.6	1906–1910	14.7
1866–1870	22.4	1911–1915	14.3
1871–1875	22.0	1916	14.4
1876–1880	20.8	1917	14.4
1881–1885	19.4	1918	17.6
1886–1890	18.9	1919	13.8
1891–1895	18.7		

From these data G. U. Yule concludes that "the death-rate (persons dying per 1000 of the population per annum) has fallen continuously since the quinquennium 1861–65, when it stood at 22.6, to 14.7 for the quinquennium 1906–10, a fall of over one third. Owing to this fall, the 'natural rate of increase' of the population, given by the excess of the birth-rate over the death-rate, has not dropped so much as might have been expected. It

[1] G. U. Yule, *loc. cit.*, p. 8.

averaged 12.0 per thousand per annum for the decade 1851–60, rose to a maximum of 14.0 for the decade 1871–80, and fell to 11.7 in the decade 1891–1900, and 11.8 in the following decade. The greatest quinquennial average reached was 14.5 in the quinquennium 1876–80." [1]

There is additional evidence that the crude death-rate has decreased. This evidence consists in the increased expectancy of life.[2] Professor Karl Pearson had his attention called by Dr. W. Flinders Petrie to the ages recorded on 141 Egyptian mummies. From these data he has [3] developed the life expectancy. He compares graphically the expectancy in those early days with that of modern England. On the whole, the expectancy to-day is much longer up to the age sixty-eight. Further evidence on the increased expectancy is supplied by similar work upon data for Rome and certain Provinces.[4] Through a graphic comparison Pearl shows much the same situation as indicated by Pearson.[5] Some of the later tables, such as the Breslau Table, also show that the current expectancy of life is far greater than in earlier times.[6] This increased life

[1] G. U. Yule, *loc. cit.*, p. 10. For data concerning the variation in the death-rate in Germany, see Paul Mombert, *Studien zur Bevölkerungsbewegung in Deutschland* (Karlsruhe, 1907), pp. 1–44; see, also, E. Levasseur, *op. cit.*, vol. II, p. 18, vol. III, p. 553 *et seq.*

[2] The expectancy of life at any age is the average number of years of survival of the individuals alive at that age.

[3] Karl Pearson, "On the Change in the Expectancy of Life in Man in Circa 2000 Years," *Biometrika*, vol. I (1902), pp. 261–64.

[4] W. R. MacDonell, "On the Expectation of Life in Ancient Rome, and in the Provinces of Hispania, and Lusitania, and Africa," *Biometrika*, vol. IX (1913), pp. 366–80.

[5] Dr. Pearl has shown both these comparisons for the Expectancy Table of the United States. *Op. cit.*, Figures 21, 22, 23, and 24.

[6] We must note here, however, the several actuarial difficulties under which these tables have been compiled. The principal difficulty is that only a knowledge of deaths is available. See the interesting work of Arne Fisher, *Frequency Curves* (New York, 1922), where he constructs a life table from a knowledge only of deaths. Fisher considers the d_x curve as being generated as a compound curve of a limited number of subsidiary

expectancy is substantially due to the great diminution in infant mortality; the decrease in mortality rates at advanced ages has been very slight. There is no question, then, that the decrease in the death-rate is not an isolated nor recent phenomenon.

Much divergence of opinion exists as to the cause for the decline in the death-rate. On the one hand there are the claims of the sanitarians and public health officials; on the other hand there are those who believe that the public health movement has affected to but a slight degree the declining trend in the death-rate.[1] Whatever conclusion is finally reached, for our present purposes it is sufficient to know that there are many forces making for a declining death-rate other than the direct activities of public health officers, whose efforts most assuredly have resulted in a lengthened life, by giving mankind a knowledge of how to struggle more successfully against an unfriendly environment. Admittedly, however, "it is entirely conceivable that more has been accomplished through the increase in real wages of the working classes of the country, through the improved working conditions of the factories, and the improved well-being of the great mass of the workers,

component curves of either the Laplacean–Charlier or Poisson–Charlier type. For a criticism of the method, see the *Proceedings of the Casualty Actuarial Society of America*, vol. VI (1922), p. 357; also review by E. W. Kopf, *Journal of the American Statistical Association*, vol. XIX (March, 1924), pp. 114–16. We must note, too, that a substantial share of this increased expectancy is due to a materially lessened infant mortality. See the interesting table quoted by Professor Whipple (*op. cit.*, p. 432) on the comparative expectancy in New York, 1879–81 and 1909–11.

[1] These issues are sharply outlined in Pearl's Lowell Lectures in December, 1920. The volume of these lectures, *The Biology of Death*, called forth a review by Dr. Louis I. Dublin, in *The Survey* (May, 1923), p. 223. Dr. Pearl replied to this review in the same journal (July 15, 1923), p. 441. Then Dr. Dublin summarized his views in an address delivered to the Nineteenth Annual Meeting of the National Tuberculosis Association, June 20, 1923, entitled "The Causes for the Recent Decline in Tuberculosis and the Outlook for the Future."

than from all the direct activities of the [anti-tuberculosis] movement itself . . ." [1] We now turn to the question of seasonality in the data.[2]

B. Seasonal Fluctuations

The question of the influence upon the death-rate of

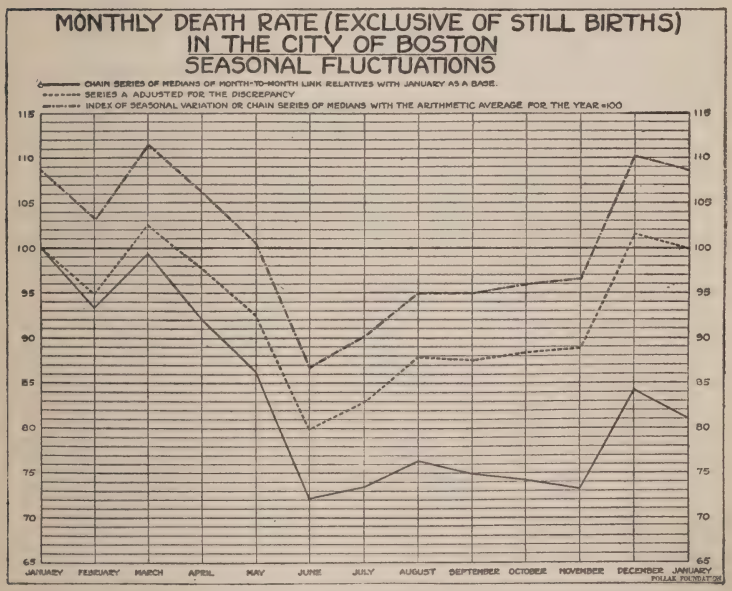

CHART II

the round of the seasons is as important as it is fascinating. Table 25 shows the Seasonal Variation in the death-rate

[1] Dublin, *loc. cit.*, p. 28.

[2] Dr. Pearl calls attention to an interesting feature of the death-rate in the reply to Dr. Dublin in *The Survey, loc. cit.*, p. 442: "It seems to me at least highly probable from what is known in the realms of bacteriology, immunology, and epidemiology that there exist, from causes in the main as yet wholly unknown, secular changes, large in amount, and regular in character, and often spread over long periods of time. . . . If this be so . . . then it must logically follow that there have been and will be large secular fluctuations in the rate of mortality quite independent of any conscious activities of mankind in the premises."

Table 25. Seasonal Indexes, Monthly Death-Rate

	Jan. / Dec.	Feb. / Jan.	March / Feb.	April / March	May / April	June / May	July / June	Aug. / July	Sept. / Aug.	Oct. / Sept.	Nov. / Oct.	Dec. / Nov.	Jan. / Dec.
Medians of Link Relatives.....	105.92	93.32	106.51	93.65	92.65	83.58	102.00	103.94	98.09	99.98	98.61	114.98	105.92
Chain Series	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.
With January as 100...	100.00	93.32	99.395	93.083	86.241	72.080	73.522	76.419	74.960	74.195	73.164	84.124	89.104
Adjusted for Discrepancy.....	100.00	94.89	102.54	97.81	92.54	79.95	82.97	87.44	87.56	88.37	88.91	101.45	100.00
With Arithmetic Average as 100.....	108.65	103.10	111.41	106.27	100.54	86.87	90.15	95.00	95.03	96.01	96.60	110.23	108.65

in Boston for the past twenty-two years. Graphically, these fluctuations are exhibited in Chart 11. It will be noted that the influence of the seasons is quite marked. There are two maximum points, namely, December and March, and one minimal month, namely, June. March is the severest month, represented by an Index of 111.41, closely followed by December with its Index of 110.23. From the month of March the curve declines to June (86.87) and then rises very slowly to November. From November the jump upward is sharp and severe to the month of December.[1] The seasonal variation for the death-rate is greater than the seasonality in the birth-rate. Professor Whipple[2] has investigated this question of seasonality in the death-rate. In the single year 1910, he found that March was the severest month, representing 9.5 per cent of all the deaths during that year; July was close behind with 9.0 per cent. There are two distinct maximal points in Professor Whipple's analysis from January through April, and the two months July and August. We must bear in mind, however, that these data refer to one single year and are not so accurate as the seasonal curve presented in Chart 11, which is based upon twenty-two years. Falk[3] presents data for the United States Registration Area in which it appears that, for the year 1919, January was the severest month; this was closely followed by February and March. These data again refer to only one year. In this case, however, they represent a much wider area. We conclude, therefore, that the influence of the seasons upon the death-rate is marked.[4]

[1] The Standard Deviation of the Monthly Fluctuations is 7.666 as compared with 2.2874 for the birth-rate; in other words, the Standard Deviation of the former is 3.35 times the latter.

[2] *Op. cit.*, p. 306. [3] *Op. cit.*, p. 183.

[4] An interesting table of seasonal indexes of mortality is given in the *Statistical Bulletin*, Metropolitan Life Insurance Company, vol. v, No. 5

An interesting question presents itself. How does this seasonality in the death-rate tie up, if at all, with the seasonal variations in the birth-rate? To answer this question the following data are presented.

COEFFICIENTS OF CORRELATION BETWEEN SEASONAL FLUCTUATIONS IN THE BIRTH-RATE AND DEATH-RATE

TIME OF CORRELATION	COEFFICIENT
Synchronous	+0.2475
Birth-rate lagging 1 month	−0.1752
Birth-rate lagging 2 months	+0.1321
Birth-rate lagging 3 months	+0.3634
Birth-rate lagging 4 months	+0.2237
Birth-rate lagging 5 months	+0.1644
Birth-rate lagging 6 months	−0.0482
Birth-rate lagging 7 months	+0.0192
Birth-rate lagging 8 months	−0.3496
Birth-rate lagging 9 months	−0.4416
Birth-rate lagging 10 months	−0.1967
Birth-rate lagging 11 months	−0.0536

These coefficients are shown in Chart 12. It will be noted that the point of maximum correlation occurs when the two curves representing seasonality in the death-rate and in the birth-rate are paired in such a manner that the one representing the seasonal fluctuations in the birth-rate lags behind the other curve by nine months. Note, however, that the correlation is inverse. In other words, the months in which the death-rate is

(May, 1924), p. 8. Indexes are given both for New York City and New York State. The first four months of the year are the severest. A table of monthly and seasonal variations in deaths is given by Harald Westergard, *Die Lehre von der Mortalität und Morbilität* (second edition, Jena, 1901), pp. 300–01. The table refers to various European states in the latter part of the eighties. January is universally the highest month. The first three months of the year contain a disproportionate number of deaths. A similar table of the seasonal variation in the number of deaths in France for the period 1861–65 is given by E. Levasseur, *op. cit.*, vol. II, p. 163; also see G. v. Mayr, *op. cit.*, vol. II, pp. 208–15.

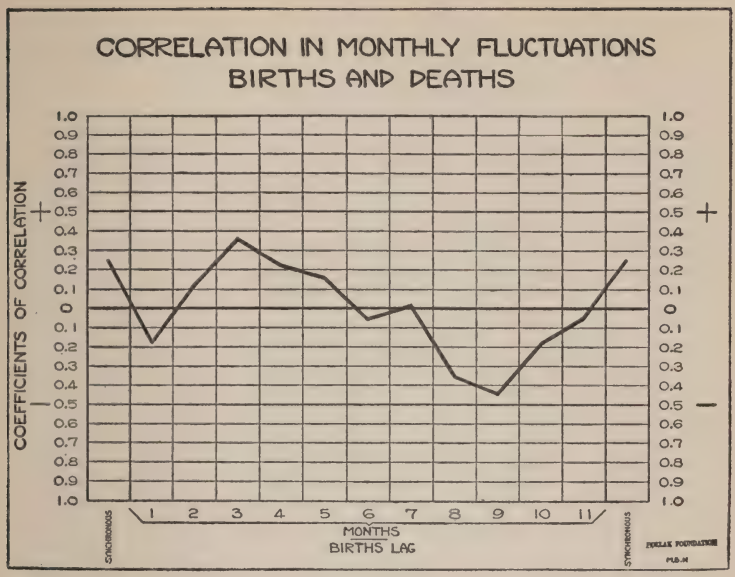

CHART 12

severe are followed nine months later by months in which the birth-rate is low; months in which the death-rate is light are followed, after an interval of nine months, by months in which the birth-rate is high. It is important to note in this connection that the death-rate is a crude index of health conditions. In other words, the number of people dying indicates the number of people sick.[1]

We have noted so far the interesting fact that both the birth-rate and the death-rate are declining. In other words, so far as the long-time tendency is concerned, despite occasional set-backs, there is positive correlation

[1] Note, however, the rather high and direct correlation at three-months lag. As we have mentioned earlier "three-months lag" may mean fifteen-months lag or six-months lag in *conceptions*. We give the fact for what it is worth, for at this time we have no reasonable interpretation to suggest. The fact is that six months after the high death-rate months more conceptions occur, and conversely.

between the two. In the seasonal variation, however, we find just the opposite to be the case; the maximum correlation is inverse. This inverse relationship in seasonal fluctuation was pointed out quite a number of years ago by Dr. Crum, when he said that "in months when deaths are many, conceptions tend to be few, and vice versa."[1] Professor Willcox likewise has alluded to this situation as follows: "As a rule influences which tend to increase deaths tend also to decrease births, and influences which tend to decrease deaths tend to increase births. This appears even in the rhythm of each day, Italian figures apparently showing that deaths are most frequent and births least frequent in the afternoon."[2] Before we turn away from this subject of the correlation of the seasonality in the birth-rate and the death-rate, we want to note that the degree of correlation is −0.4416, whereas in correlating the seasonality of the birth-rate with marriages we found the coefficient to be +0.7109, likewise for the nine-months lag in the birth-rate. In other words, the relationship between marriage and births is more marked than that between births and deaths.

C. Cyclical Fluctuations

Tables 27 and 28 show the Cyclical Fluctuations in the death-rate.[3] These two tables are reflected in Chart 13. From the Chart, it will be noted that, as in the case of the birth-rate and the stillbirth-rate, the fluctuations are not so regular as are those met with in data more directly reflecting the economic situation. In addition, the Cyclical

[1] F. S. Crum, "The Birth-Rate in Massachusetts," *Quarterly Journal of Economics*, vol. XI (1897), p. 265.

[2] *Loc. cit.*, p. 2; see, also, E. Levasseur, *op. cit.*, vol. II, p. 174.

[3] In these Cycle Figures we have estimated the excess in the death-rate due to the influenza epidemic, and allowed for this exceptional feature in the months of September, 1918, through January, 1919.

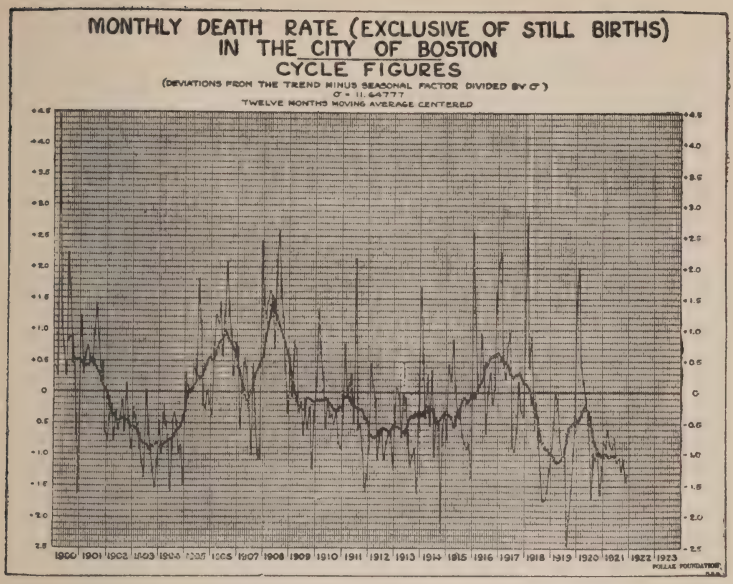
MONTHLY DEATH RATE (EXCLUSIVE OF STILL BIRTHS)
IN THE CITY OF BOSTON
CYCLE FIGURES
(DEVIATIONS FROM THE TREND MINUS SEASONAL FACTOR DIVIDED BY σ')
σ' = 11.64777
TWELVE MONTHS MOVING AVERAGE CENTERED
1900 1901 1902 1903 1904 1905 1906 1907 1908 1909 1910 1911 1912 1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923

CHART 13

Fluctuations in the death-rate show a wider amplitude than those of the birth-rate.[1] We found the same relationship between the seasonal fluctuations in both these variables. It can be said, then, that the death-rate varies far more than the birth-rate.

Let us turn to the Chart and follow the Cyclical Fluctuations as shown by the Twelve-Months Moving Average. The curve starts above the line in 1900. For the year 1900 and for the first half of 1901 it remains there. Then begins an extremely gradual decline until in January, 1902, the curve crosses the line on its downward course. It continues at about the same, or possibly at a slightly

[1] The Standard Deviation of the Cycle Figures for the death-rate is 2.18 times the Standard Deviation for the birth-rate. Note, too, the larger Coefficient of Disturbancy, alluded to above.

TABLE 27. CYCLE FIGURES, MONTHLY DEATH-RATE (EXCLUSIVE OF STILLBIRTHS) IN THE CITY OF BOSTON

$\sigma = 11.64777$

YEAR	January	Febfuary	March	April	May	June	July	August	September	October	November	December
1900	.426	+ .252	+4.447	+1.120	+ .628	+ .253	+2.218	+1.571	+ .452	+ .466	− .346	−1.636
1901	1.233	+ .274	+ .525	+ .745	+ .528	+ .431	+ .905	+1.423	+ .872	+ .286	+ .483	− .668
1902	− .776	− .423	− .202	− .786	− .326	− .629	− .398	− .130	− .649	+ .142	− .466	− .922
1903	− .266	− .418	− .614	− .847	−1.129	−1.364	+ .028	− .673	− .842	−1.253	−1.531	−1.102
1904	− .471	−1.002	− .216	− .556	− .742	−1.591	− .504	− .338	− .485	− .974	− .850	−1.485
1905	+ .310	+ .086	− .012	+0.0	+ .397	+ .252	+1.812	+1.118	− .215	− .276	+ .021	− .187
1906	− .419	+ .694	+1.235	+1.070	+1.452	+ .572	+1.223	+2.066	+1.232	+ .919	+ .248	+ .802
1907	+ .724	− .598	+ .135	+ .545	+ .355	− .248	−1.023	+ .459	− .588	−1.105	−1.096	+2.426
1908	+1.406	+1.165	+1.443	+1.626	+1.543	+ .689	+2.085	+2.595	+1.613	+1.144	+ .423	− .353
1909	+ .386	− .088	+ .809	+ .649	− .353	− .150	− .703	− .239	− .605	− .235	−1.236	− .320
1910	+ .164	+1.328	+ .632	+ .242	− .574	− .138	− .408	− .364	− .523	− .270	− .835	− .924
1911	− .360	+ .774	− .089	+ .185	+ .303	− .489	+2.140	− .610	− .533	−1.108	−1.589	−1.302
1912	− .821	+ .471	+ .086	− .102	−1.081	− .695	− .583	−1.095	− .828	− .711	− .605	−1.245
1913	− .266	+ .076	− .015	− .731	− .039	− .091	− .831	−1.200	−1.044	− .923	−1.622	− .022
1914	+1.666	+ .548	− .408	+ .294	− .543	+ .343	−1.036	− .397	− .470	−2.248	− .606	− .298
1915	− .758	+ .450	+ .176	+ .853	− .084	− .295	− .405	− .704	− .815	− .922	− .818	−1.367
1916	+2.546	+1.068	+ .052	+ .086	+ .942	+ .149	− .665	− .014	+ .322	− .190	+ .038	+1.589
1917	+2.054	+2.237	+ .492	+ .213	+ .749	+ .962	− .868	− .946	− .577	+ .173	− .304	− .410
1918	+1.295	+2.806	+ .381	+ .902	− .610	− .155	− .755	−1.393	−1.730*	−1.710*	−1.600*	−1.260*
1919	− .890*	− .530*	− .009	− .152	− .779	−1.048	−1.023	−2.469	−2.018	−1.526	−1.004	− .613
1920	+1.704	+2.007	+ .425	+ .142	− .063	− .440	−1.696	− .980	−1.113	− .961	−1.641	−1.182
1921	− .780	− .924	− .604	− .848	− .927	− .737	−1.131	−1.061	−1.267	−1.075	−1.438	−1.313

* Interpolated magnitudes.

TABLE 28. TWELVE-MONTHS MOVING AVERAGE OF CYCLE FIGURES, MONTHLY DEATH-RATE (EXCLUSIVE OF STILLBIRTHS) IN THE CITY OF BOSTON

YEAR	January	February	March	April	May	June	July	August	September	October	November	December
1900						+ .821	+ .888	+ .890	+ 563	+.532	+ .524	+ .538
1901	+ .429	+ .417	+ .452	+ .437	+ .506	+ .586	+ .419	+ .361	+.300	+.173	+ .102	+ .013
1902	− .095	− .225	− .351	− .364	− .443	− .464	− .421	− .421	−.455	−.460	− .527	− .588
1903	− .553	− .598	− .614	− .731	− .819	− .834	− .851	− .900	−.867	−.843	− .810	− .829
1904	− .874	− .846	− .816	− .793	− .736	− .768	− .703	− .612	−.595	−.549	− .454	− .300
1905	− .107	+ .014	+ .037	+ .095	+ .167	+ .276	+ .215	+ .265	+.369	+.459	+ .546	+ .573
1906	+ .524	+ .603	+ .724	+ .823	+ .842	+ .925	+1.020	+ .912	+.820	+.777	+ .685	+ .617
1907	+ .430	+ .296	+ .144	− .025	− .137	− .001	+ .056	+ .203	+.312	+.402	+ .500	+ .579
1908	+ .838	+1.016	+1.199	+1.387	+1.513	+1.273	+1.188	+1.084	+.964	+.882	+ .724	+ .654
1909	+ .422	+ .186	+ .001	− .114	− .177	− .174	− .192	− .074	−.089	−.123	− .141	− .140
1910	− .116	− .131	− .119	− .122	− .089	− .139	− .183	− .229	−.289	−.294	− .221	− .250
1911	− .038	− .058	− .058	− .129	− .200	− .223	− .262	− .287	−.272	−.296	− .412	− .429
1912	− .656	− .696	− .721	− .688	− .606	− .601	− .555	− .588	−.597	−.648	− .561	− .515
1913	− .532	− .541	− .559	− .576	− .661	− .559	− .398	− .359	−.391	−.306	− .348	− .312
1914	− .329	− .262	− .214	− .325	− .240	− .263	− .465	− .473	−.424	−.378	− .340	− .400
1915	− .341	− .366	− .401	− .549	− .302	− .391	− .115	− .064	−.074	−.138	− .053	− .016
1916	− .037	+ .021	+ .115	+ .175	+ .247	+ .494	+ .453	+ .550	+.587	+.597	+ .581	+ .649
1917	+ .632	+ .554	+ .479	+ .510	+ .481	+ .315	+ .251	+ .299	+.289	+.347	+ .235	+ .141
1918	+ .150	+ .113	+ .016	− .140	− .248	− .319	− .501	− .779	−.812	−.900	− .914	− .988
1919	−1.010	−1.100	−1.124	−1.109	−1.059	−1.005	− .789	− .579	−.541	−.517	− .457	− .407
1920	− .463	− .339	− .263	− .216	− .269	− .317	− .524	− .768	−.854	−.936	−1.008	−1.033
1921	− .986	− .992	−1.005	−1.015	− .998	−1.009						

retarded rate, until it reaches its lowest ebb in August, 1903. Then the curve begins to climb at a slightly more rapid rate than that with which it fell; and it crosses the line on its upward course in February, 1905. At a slightly retarded rate, the curve continues to rise until it reaches its peak in July, 1906. Suddenly, the curve begins a precipitous decline, crossing the line in April, 1907. The death-rate remains below the line only three months, recrossing the line in July of the same year. It continues its upward course at a high rate, and reaches its highest point in May, 1908, when the curve registers +1.513. Then, once more, a precipitous decline commences and the curve crosses the line in April, 1909. Then for a period of about two and one-half years the death-rate hovers just below the line.[1] In November, 1911, however, the curve falls farther. This ebb continues until March, 1912. From then on, with minor fluctuations, the curve rises. About four years later, it crosses the line, and it continues to rise until December, 1916. Then the curve begins a gradual decline until it crosses the line in April, 1918. Continuing on its downward career, the death-rate reaches the lowest point in its Cyclical Fluctuations in March, 1919. Then the curve begins to rise, never sufficiently, however, to cross the line until April, 1920, when it registers −0.216. From that time, until the close of the present series, the curve falls, so that for the year 1921 it hovers about the −1.000 line. This describes the course of the Cyclical Fluctuations in the death-rate for the past twenty-two years.

[1] Somewhat the same situation was noted in these years in the birth-rate.

CHAPTER V

THE NUMBER OF MARRIAGES

A. The Trend

TABLE 31 presents the number of marriages monthly in Boston from January, 1900, through December, 1920. These data are plotted in Chart 14. It will be noted that the month in which the largest number of marriages

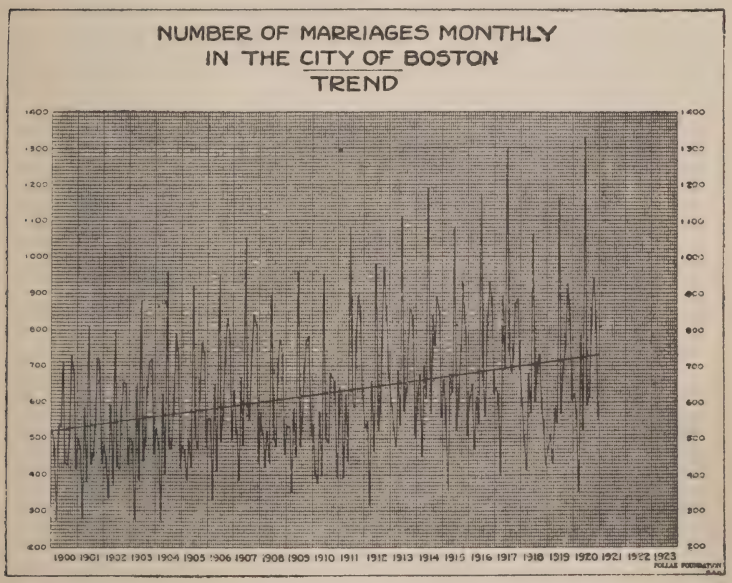

CHART 14

occurred was June, 1920, with 1329 marriages. Near to this peak month is June, 1917, with 1300. March, 1904, with only 275 marriages was the lowest month throughout this entire span of months. Three other months are close to this lowest month. They are March in 1900, 1901,

Table 31. Number of Marriages Monthly in the City of Boston

Year	January	February	March	April	May	June	July	August	September	October	November	December
1900	523	485	276	538	531	711	431	426	493	731	688	416
1901	501	468	277	585	382	807	427	447	549	721	716	430
1902	482	441	334	592	370	802	422	414	581	657	649	428
1903	500	490	277	638	385	881	436	500	647	712	718	456
1904	527	476	275	622	403	960	469	471	601	788	728	416
1905	480	462	387	497	421	916	508	471	659	766	734	474
1906	553	554	335	648	412	952	492	573	739	830	790	496
1907	631	517	384	668	483	1052	594	554	745	842	808	433
1908	568	506	421	522	433	894	499	479	702	773	740	456
1909	534	531	353	583	448	958	477	546	692	769	779	506
1910	539	402	377	573	397	950	498	487	683	667	649	395
1911	640	628	393	622	440	1080	596	585	781	892	856	598
1912	530	545	315	658	467	981	524	590	792	972	830	681
1913	596	525	479	688	537	1110	575	637	780	854	836	503
1914	634	677	452	702	611	1188	570	840	756	888	849	557
1915	664	581	357	682	626	1078	525	637	758	924	790	509
1916	610	644	471	614	541	1174	676	562	836	929	870	624
1917	640	620	398	894	695	1300	769	684	744	869	884	694
1918	598	495	415	678	570	1059	599	712	730	568	545	426
1919	476	509	432	585	544	1163	571	691	743	922	883	603
1920	622	576	352	782	520	1329	592	609	856	941	816	550

and 1904. There is, then, quite a wide divergence between the peak month and the lowest month. The lowest month represents 20.69 per cent of the heaviest month.

One glance at Chart 14 shows that there has been a steady increase in the number of marriages since 1900. The straight line through the data represents the trend line. It will be recognized readily that for the period under review a straight [1] line "fits" the data very well. The equation to the curve is $y = 624.2957 + .8472\,x$, the origin being June, 1910. The lowest ordinate of trend (January, 1900) is 518.3957; the highest ordinate of trend (December, 1920) is 731.0429. This represents an increase in the trend line of 41.02 per cent during these twenty-one years. The population of Boston in 1900 was 560,892; by 1920 it had increased to 748,060.[2] This represents an increase in population of 33.37 per cent. In other words, marriages have increased more rapidly than population in the City of Boston.

The following tabulation presents the marriage-rates in Massachusetts yearly since 1869, and for the City of Boston for certain years since 1880:

[1] While a straight line "fits" the data under review, other series reflecting marriage-rates do not provide the same straight-line development. Professor Davies found that the marriages annually per 100,000 population in the United States, 1887–1906, might be represented by a parabola, the equation of which is $y = 88.5 - 0.6\,x + 0.08\,x^2$ with the origin at 1887. George R. Davies, "The Social Aspects of the Business Cycle," *The Quarterly Journal of the University of North Dakota*, vol. XII, No. 2 (January, 1922), p. 112. Ogburn and Thomas (*loc. cit.*, p. 331) found that for the fifty-one years, 1870–1920, a parabola "fitted" best. Its equation is $y = 17.65 + 0.055\,x + 0.0032\,x^2$.

[2] *The Population of Massachusetts, as determined by the Fourteenth Census of the United States*, compiled by Frederic W. Cook and William Grundy (Boston, 1921), p. 18.

Year	Massachusetts	Boston	Year	Massachusetts	Boston
1869	23.43		1896	18.1	
1870	20.2		1897	17.6	
1871	21.1		1898	16.5	
1872	21.1		1899	17.2	
1873	20.9		1900	17.4	21.6
1874	19.3		1901	17.3	
1875	16.3		1902	17.5	
1876	15.2		1903	17.9	
1877	15.0		1904	16.9	
1878	14.9		1905	18.1	22.8
1879	15.7		1906	19.5	
1880	17.4	29.1	1907	20.1	
1881	18.5		1908	17.3	
1882	19.2		1909	16.2	
1883	19.4		1910	18.2	22.1
1884	18.2		1911	18.6	
1885	17.6	20.6	1912	17.6	
1886	18.0		1913	17.6	
1887	19.0		1914	17.9	
1888	18.2		1915	17.0	21.8
1889	18.8				
1890	18.6	21.8	1916	18.2	22.5
1891	18.9		1917	19.8	23.6
1892	19.2		1918	14.9	18.6
1893	19.1		1919	17.9	21.7
1894	16.9		1920	19.7	20.1
1895	18.5	21.0			

A rough inspection of the data indicates that there has been no drop in the marriage-rate in Massachusetts. The course of development has not been, however, in a straight line such as we were able to use for the shorter period, 1900 through 1920. For the marriage-rates since about 1870, covering areas in which Massachusetts is included, other writers [1] use a parabola concave upwards. Professor Whipple reaches the same conclusion. He says: "There has been no steady downward trend in the marriage-rate as in the case of the death-rate and the birth-

[1] Ogburn and Thomas, *loc. cit.*, p. 332, for the years 1870–1920; and Davies, *loc. cit.*, p. 112, for the years 1875–94.

rate."[1] On the other hand, Dr. Crum[2] states that from 1850–90 the trend in Massachusetts was downward. The same may be said of the marriage-rate in Boston. The high rate of 29.1 in 1880 is due probably to exceptional causes, operative locally in that year, for the rate for the whole State does not show the same bulge. With the exception of that one year, it is plain that the marriage-rate in Boston shows a rise.

A number of recent students have given some attention to the course of the marriage-rate in England. Lucien March,[3] Hooker,[4] Yule,[5] Bowley,[6] Knibbs,[7] and others have carefully analyzed the rate. The conclusion fairly well agreed upon is that in England the marriage-rate has fallen since the middle of the last century; that the decline is not a persistent one, but was rather sharp late in the seventies; and that the decline is far less rapid than the decline in the birth-rate which we have noted earlier in the British Isles.[8]

[1] Whipple, *op. cit.*, p. 215. [2] Crum, *loc. cit.*, pp. 328–29.

[3] Lucien March, "Comparaison numérique de courbes statistiques," *Journal de la Société de Statistique de Paris*, vol. XIX (1905), pp. 255, 306.

[4] R. H. Hooker, in the *Transactions of the Manchester Statistical Society* (1897–98), p. 101, where Hooker demonstrated that the marriage-rate in England had not fallen gradually, but rather had dropped abruptly to a new level in the years 1876–79. He said, "That such a phenomenon was explicable upon the supposition of a gradual increase in the age at marriage, in other words, of a gradual deferment of marriage; and, further, that the progressive increase of 0.055 year in the age at marriage shown in the Registrar-General's returns would result in the marriage-rate which obtained after 1876. There was also some evidence to show that prior to 1876 the marriage-rate had been falling, and that there had been a progressive hastening of marriage at a probably not dissimilar rate."

[5] G. U. Yule, "Changes in the Marriage- and Birth-Rates in England and Wales during the past Half-Century," *Journal of the Royal Statistical Society*, vol. LXIX (March, 1906), p. 122 *et seq.*

[6] A. L. Bowley, *Elements of Statistics* (3d ed., London, 1907), p. 174.

[7] Knibbs, *loc. cit.*

[8] For detailed data on the fluctuations in Germany and certain other continental countries, see the following: J. Conrad, *Grundriss zum Studium der politishen Oekonomie*, Part IV, Bevölkerungstatistik (fifth edition, reworked

Before we leave the matter of the declining trend in the marriage-rate, there is one further observation to be made. There are certain data to show that the marriage-rate varies more in the fluctuations in trend over longer swings of years than do most other historical-biological series. The conformation of the line expressing the trend in the marriage-rate from 1870 to 1890 used by Dr. Ogburn and Miss Thomas, together with the careful studies of Dr. Crum, would seem to indicate that the rhythmic fluctuations in this phenomenon are of much longer duration than periods normally used in the determination of trend. In other words, it is quite possible that there are these major trends which include periods of minor trends of various lengths and conformation.[1] Before this hypothesis can be demonstrated, however, much work will have to be done after many more years of careful collection of vital statistics.

B. Seasonal Fluctuations

We turn, now, to a study of the variations in the number of marriages occasioned by the round of the seasons. Among the several series discussed in this volume that reflect the pulse-beats[2] of a community, the seasonality of

by A. Hesse, Jena, 1923), pp. 123–31; N. Simon, "Die Entwieklung der Heiratsziffer in Preussen seit 1875," *Zeitschrift der Preussische Statistichen Landesamts*, 61 Jg.; Georg von Mayr, *Statistik und Gesellschaftslehre*, vol. III (Tübingen, 1917), p. 170 ff.; Fr. Prinzing, "Die Wandlungen der Heiratshaufigkeit und des mittleren Heiratsalter," *Zeitschrift für Sozialvissenschaft*, Jg. 5; Mombert, *op. cit.*, pp. 86–94; G. Schmoller, *Grundriss der Allgemeinen Volkwirtschaftlehre*, Part I (Leipzic, 1908); for a discussion of the fluctuations in the number of marriages in France, see E. Levasseur, *op. cit.*, vol. II, pp. 68–71. For data on the average price of grain and the number of marriages per 1000 population, by decades from 1801 through 1869, see G. v. Mayr, *op. cit.*, vol. II, pp. 377–81.

[1] See Vilfrédo Paréto, *Traité de Sociologie Générale* (Édition Française, Paris, 1919), vol. II, p. 1065, footnote.

[2] Sir W. H. Beveridge used the suggestive phrase "The Pulse of the Nation" in his volume on *Unemployment* sixteen years ago.

marriage is, by far, the best known. Many statistical inquiries mention this fact; none that we have discovered utilizes a method by which it is possible to measure the

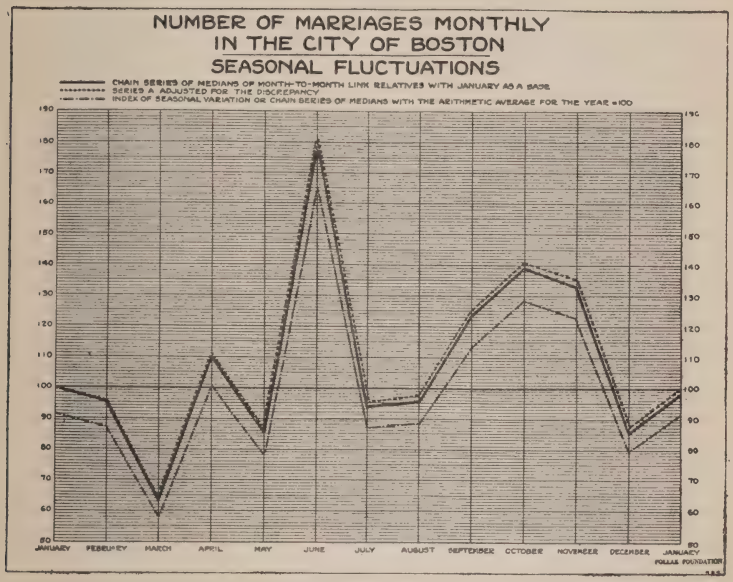

CHART 15

relative changes occasioned by the variations in the seasons.[1] The seasonal fluctuation is shown in Table 35. Graphically, these data are shown in Chart 15. This Table and Chart show in striking fashion the extreme seasonal variation in these phenomena.[2] June registers 163.80; then the months of September, October, and November represent a secondary peak, with the seasonal in-

[1] "There is, however, a seasonal variation. June and October are the most popular months for weddings." (Whipple, *op. cit.*, p. 215.)

[2] The Standard Deviation of the seasonal fluctuations is 40.136025. In this connection see footnote on page 24 where the Charlier "coefficient of disturbancy" is given.

Table 35. Seasonal Indexes, Number of Marriages Monthly

	Jan. / Dec.	Feb. / Jan.	March / Feb.	April / March	May / April	June / May	July / June	Aug. / July	Sept. / Aug.	Oct. / Sept.	Nov. / Oct.	Dec. / Nov.	Jan. / Dec.
Medians of Link Relatives	115.94	93.27	66.39	173.70	76.74	213.54	52.54	100.76	128.79	112.90	95.68	64.48	115.94
Chain Series	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.
With January as 100	100.00	93.27	61.92	107.56	82.54	176.26	92.61	93.31	120.17	144.41	138.17	89.09	103.29
Adjusted for Discrepancy	100.00	92.996	61.372	106.738	81.444	174.89	90.966	91.392	117.978	141.944	135.43	86.076	100.00
With Arithmetic Average as 100	93.66	87.10	57.48	99.97	76.28	163.80	85.20	85.60	110.50	132.94	126.84	80.62	93.66

dex respectively of 110.50, 132.94, and 126.84.[1] At present, it is possible only to speculate as to the reason for this pronounced influence of the seasons. There are two broad groups of explanations: the one explains these variations in terms of social influences, such as the prospect of summer vacations, seasonal unemployment, and the quiet incident upon the harvesting of the crops.[2] The other group of explanations revolves around the seasonal variation which still remains in the sexual desires of man. This seasonality of the sex desire is looked upon as the survival of the primitive pairing seasons. Westermarck[3] writes as follows: "If we thus find in man, even to this day, an increase either of the sexual desire or of the reproductive power in the spring or at the beginning of summer, I think we may look

[1] The following table gives indexes for marriages in two large religious groups in Germany:

Month	1872–75	1872–80		
		Pure Protestant Districts	Pure Catholic Districts	In General
January	102	79	111	97
February	116	93	151	118
March	45	69	35	55
April	125	136	98	116
May	124	119	129	123
June	91	90	105	92
July	84	83	98	84
August	69	63	75	68
September	105	91	100	95
October	121	136	124	127
November	155	148	148	155
December	68	95	34	73

Handwörterbuch der Staatswissenschaften (Jena, 1910), vol. v, p. 449.

[2] Wappäus, *op. cit.*, p. 241. D. S. Thomas, "Changes in Marriage Seasons," *Economica* (February, 1924); G. v. Mayr, *op. cit.*, vol. II, p. 379.

[3] Edward Westermarck, *The History of Human Marriage* (5th ed., London, 1921), vol. I, p. 97; George E. Howard, *A History of Matrimonial Institutions* (Chicago, 1904), vol. I, pp. 93–151.

upon it as a survival of a pairing season among our early human or prehuman ancestors." We have seen above that when we correlate the seasonal variation in marriage with the seasonal variation in the legitimate birth-rate with the birth-rate lagging nine months (that is when we pair the two curves for marriage and *conception*), we arrive at a very high coefficient, namely, +.7109; when we correlate the birth-rate with seasonality in *employment* nine months earlier, we obtain a coefficient which is not quite so high, namely, +.3121 (for seasonal variation in employment ten months previous, the coefficient of correlation is +.4749). If we study the relationship of marriage and the birth-rate by the method of partial correlation,[1] we find that the coefficient of correlation for marriage and conception, with the effect of employment constant, is +.6733. The coefficient for employment and conception, with the effect of marriage held constant, is −.0501, or practically zero.[2] We conclude that the relationship (it may be a causal relationship) between marriage and conception is far stronger than the relationship between conception and employment. As we have mentioned earlier, there is much evidence to show that marriage is rooted in the family rather than family in marriage.[3] The question then arises whether this high seasonal variation in marriage is the modern response to seasonal variation of the sex instinct. In other words, is this seasonality in marriage the modern survival of the pairing seasons among primitive

[1] For an explanation of the method, see G. Udny Yule, *An Introduction to the Theory of Statistics* (6th ed., London, 1922), pp. 229–53; Truman Lee Kelley, *Statistical Method* (New York, 1923), pp. 279–311; Brown and Thomson, *Essentials of Mental Measurement* (Cambridge, 1921), pp. 134–38; L. Isserlis, "On the Partial Correlation Ratio," *Biometrika*, vol. x (1914), pp. 391–411; Armand Julin, *Principes de Statistique Théorique et Appliquée* (Paris, 1921), vol. I, pp. 547–53.

[2] The sign may be significant, as we shall see later.

[3] Westermarck, *op. cit.*, vol. I, p. 72.

groups? We may well question whether in modern society, with its long and lengthening periods of courtship, marriage constitutes this *direct* response to sex.[1] What has probably occurred is that these primitive pairing seasons have maintained themselves, and that marriages in earlier times implied a direct response to the seasonal variation in the sex impulse;[2] but that in current society the *time* of marriage is rooted as well in certain *social* influences, such as the vacation periods and time of harvests. We are urged to this conclusion by the results obtained when correlating the seasonal fluctuations in marriages with the seasonal fluctuations in unemployment. These findings are shown in the following table:

COEFFICIENTS OF CORRELATION BETWEEN SEASONAL FLUCTUATIONS IN MARRIAGES AND UNEMPLOYMENT

TIME OF CORRELATION	THE COEFFICIENT
Synchronous	−.4824
Marriages lag 1 month	−.4679
Marriages lag 2 months	−.4638
Marriages lag 3 months	−.0564
Marriages lag 4 months	+.1871
Marriages lag 5 months	+.2886
Marriages lag 6 months	+.4135
Marriages lag 7 months	+.1466
Marriages lag 8 months	+.1959
Marriages lag 9 months	+.1791
Marriages lag 10 months	+.1705
Marriages lag 11 months	−.1107
Synchronous	−.4824

[1] "In civilized man, so far as is known, ovulation is never confined to any particular season of the year; conception can, therefore, follow copulation at any period. But we do find evidence of the former existence in man of a special sexual season, and this is of particular interest because it suggests that at one time there was in man, as there usually is in monkeys, one season only during which conception could follow copulation." (Carr-Saunders, *op. cit.*, p. 92.)

[2] There are a number of writers, however, who state that the seasonal distribution of marriages exercises very little if any influence upon the distribution of births. J. Bertillon, "Natalité," *Dictionnaire encyclopédique des sciences médicales*, vol. XI (1875), p. 479; Wappäus, *op. cit.*, p. 242; see especially, Westermarck, *op. cit.*, vol. I, pp. 97–98.

These coefficients[1] are shown in Chart 16. It will be noted that, with one exception, all the substantial coefficients are negative. In other words, the seasonal

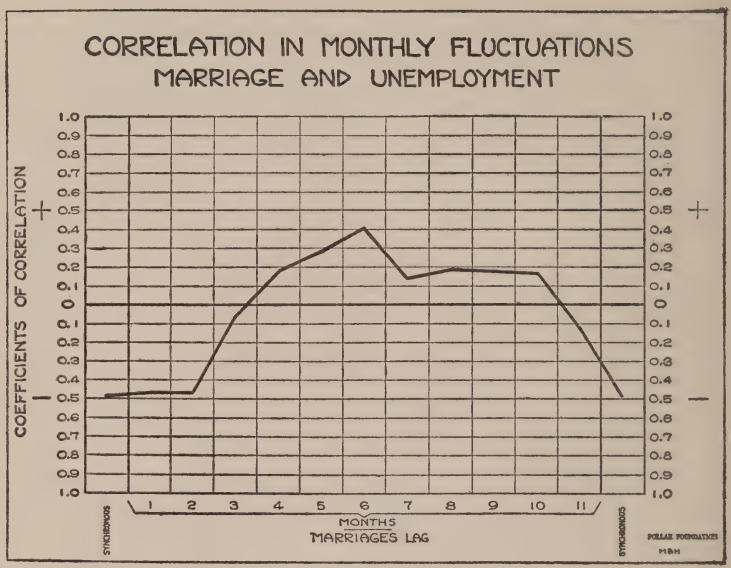

CHART 16

fluctuation in marriages is inversely correlated with unemployment or positively correlated with *employment:* months of much employment are likewise months of peaks in marriages. (It may well be that the substantial positive correlation at six-months lag reflects forced marriages, which usually are consummated during the sixth month of pregnancy. It is, furthermore, well-known that illegitimate births are directly related to leisure.) This necessarily removes part, though not the whole, of the argument of the influence of social institutions on the seasonal variation in the number of marriages, since, when

[1] The Standard Deviation of the seasonal fluctuations is 27.936.

there is less work [1] (that is, more leisure), there are fewer marriages. There still remains, nevertheless, the influence of vacation periods, postponement of marriages of college graduates until the close of the college year, and kindred social institutions. We think, nevertheless, that the evidence mentioned above lends color to the belief that seasonality of marriage in some way does indicate the modern response to former pairing seasons.

We call attention, likewise, in Chart 16 and the data which it depicts, to the fact of the high correlations when the curves of seasonality in the marriages contracted and in unemployment are paired concurrently. In that case the coefficient is −.4824. Close to this coefficient are the two secured when the curves are paired for a lag of one month and two months in the marriage curve. In those cases, we secure coefficients of −.4679 and −.4638. We must conclude, then, that the relationship between the *seasonal* fluctuations in these two social phenomena is closest when the pairing is either concurrent, or for a lag of one or two months.

C. Cyclical Fluctuations

We have discussed thus far the question of the trend in marriages and the phenomenon of seasonal fluctuation. We turn, now, to a discussion of the variations which are cyclical.

Tables 37 and 38 show the cyclical fluctuations in marriages from 1900 through 1920. The data of both these Tables are plotted in Chart 17. A comparison with earlier charts picturing similar data for the birth-rate, the stillbirth-rate, and the death-rate (Charts 5, 9, and

[1] It will be recalled that we are utilizing the seasonal variation of unemployment in leading *trades* in New York State. For the *industries* involved, see Berridge, *loc. cit.*, p. 15.

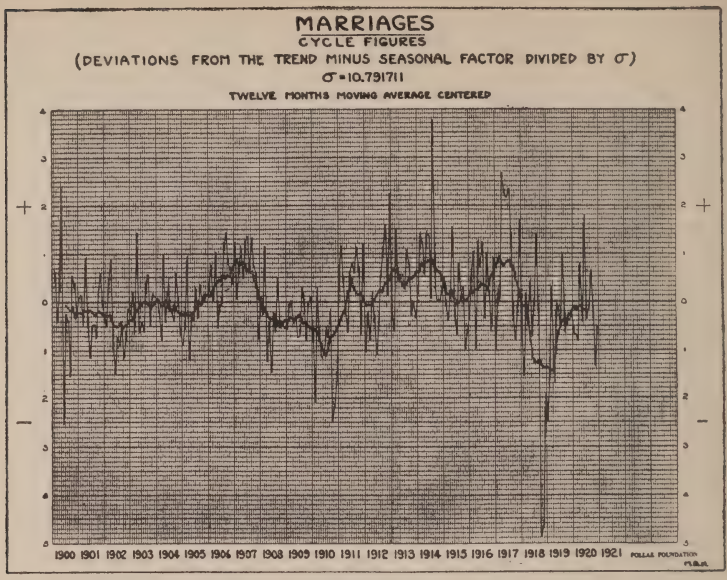
MARRIAGES
CYCLE FIGURES
(DEVIATIONS FROM THE TREND MINUS SEASONAL FACTOR DIVIDED BY σ)
σ=10.791711
TWELVE MONTHS MOVING AVERAGE CENTERED
1900 1901 1902 1903 1904 1905 1906 1907 1908 1909 1910 1911 1912 1913 1914 1915 1916 1917 1918 1919 1920 1921

CHART 17

13) shows that these cyclical fluctuations do not to the same extent range away from both the zero line and from the line showing the Twelve-Months Moving Average.

Three months stand out rather prominently on the Chart. The first in point of time is August, 1914, when the Cycle Figure registered +3.744 which represented an increase over the month preceding of 3.706 Units of the Standard Deviation (since July, 1914, registered +0.038) which constitutes a very wide and sudden rise. This was the month in which the War began. A comparison with Charts 5, 9, and 13, referring to the earlier phenomena studied, does not show this close connection with the opening of hostilities. It may be that the present incident is fortuitous. We doubt it, however, because the present study, as well as many others, demonstrates the deli-

TABLE 37. CYCLE FIGURES, NUMBER OF MARRIAGES MONTHLY IN THE CITY OF BOSTON

$\sigma = 10.791711$

YEAR	January	February	March	April	May	June	July	August	September	October	November	December
1900	+ .670	+ .583	− .409	+ .307	+2.362	−2.572	− .266	− .399	−1.541	+ .559	+ .346	− .205
1901	+ .104	+ .121	− .487	+ .944	− .414	−1.144	− .480	− .461	− .737	+ .142	+ .600	− .121
1902	− .388	− .499	+ .400	+ .871	− .744	−1.490	− .704	− .889	− .369	−1.176	− .764	− .146
1903	− .236	+ .188	− .664	+1.458	− .609	− .418	− .602	+ .418	+ .550	− .463	+ .183	+ .099
1904	+ .057	− .194	− .782	+ .999	− .429	+ .614	− .194	− .208	− .397	+ .567	+ .133	− .689
1905	− .865	− .561	+ .955	−1.209	− .256	− .377	+ .301	− .344	+ .363	− .014	+ .021	− .121
1906	+ .165	+ .777	+ .015	+1.049	− .518	− .063	− .095	+1.139	+1.442	+ .783	+ .702	+ .337
1907	+1.239	+ .044	+ .692	+1.191	+ .480	+1.239	+1.361	+ .689	+1.338	+ .747	+ .581	− .771
1908	+ .096	− .264	+1.160	−1.232	− .416	−1.462	− .249	− .604	+ .486	− .525	− .479	− .533
1909	− .565	− .015	+ .022	− .443	− .300	− .723	− .708	+ .283	+ .159	− .779	− .080	+ .102
1910	− .623	−2.072	+ .292	− .735	−1.168	−1.078	− .513	− .722	− .143	−2.472	−2.186	−1.655
1911	+ .731	+1.149	+ .437	− .155	− .634	+ .595	+ .798	+ .589	+1.122	+ .640	− .666	+1.193
1912	−1.010	− .195	− .780	+ .218	− .346	−1.076	− .374	+ .527	+1.100	+1.581	+ .100	+2.242
1913	− .190	− .604	+1.478	+ .405	+ .541	+ .529	+ .232	+1.059	+ .756	− .295	000	− .341
1914	+ .214	+1.411	+1.181	+ .544	+1.457	+1.377	+ .038	+3.744	+ .256	− .008	000	+ .223
1915	+ .492	− .057	− .409	+ .111	+1.534	− .382	− .697	+ .790	+ .125	+ .301	− .977	− .536
1916	− .379	+ .680	+1.057	− .940	+1.244	+ .696	+1.234	− .361	+1.023	+ .182	− .628	+ .905
1917	− .991	+ .231	− .003	+2.677	+2.204	+2.146	+2.339	+1.159	− .363	− .796	− .047	+1.707
1918	− .778	−1.539	+ .144	− .338	+ .426	− .716	− .037	+1.396	− .687	−4.895	−4.639	−1.916
1919	−2.480	−1.441	+ .287	−1.672	− .017	− .122	− .511	+ .993	− .655	− .439	− .390	− .281
1920	− .693	− .684	− .817	+ .741	− .424	+1.786	− .348	− .176	+ .648	− .363	−1.398	− .499

TABLE 38. TWELVE-MONTHS MOVING AVERAGE OF CYCLE FIGURES, NUMBER OF MARRIAGES MONTHLY IN THE CITY OF BOSTON

YEAR	January	February	March	April	May	June	July	August	September	October	November	December
1900						− .047	− .094	− .133	− .140	− .086	− .319	− .199
1901	− .216	− .222	− .154	− .190	−.168	− .161	− .202	− .254	− .180	− .186	− .213	− .242
1902	− .261	− .297	− .266	− .376	−.490	− .492	− .479	− .422	− .510	− .461	− .450	− .361
1903	− .352	− .243	− .167	− .107	−.028	− .008	+ .016	− .015	− .025	− .063	− .049	+ .038
1904	+ .072	+ .019	− .060	+ .026	+.022	− .044	− .120	− .151	− .006	− .190	− .176	− .258
1905	− .217	− .229	− .165	− .214	—.223	− .155	− .070	+ .042	− .036	+ .152	+ .130	+ .156
1906	+ .123	+ .247	+ .337	+ .403	+.460	+ .477	+ .567	+ .506	+ .563	+ .574	+ .658	+ .766
1907	+ .888	+ .850	+ .756	+ .838	+.828	+ .736	+ .641	+ .615	+ .654	+ .452	+ .378	+ .152
1908	+ .018	− .090	− .161	− .267	−.355	− .335	− .390	− .370	− .464	− .382	− .389	− .326
1909	− .366	− .275	− .319	− .340	−.307	− .254	− .259	− .430	− .408	− .432	− .504	− .534
1910	− .518	− .601	− .627	− .768	−.943	−1.090	− .977	− .708	− .696	− .648	− .603	− .464
1911	− .355	− .246	− .140	+ .119	+.246	+ .483	+ .338	+ .226	+ .125	+ .156	+ .180	+ .041
1912	− .057	− .062	− .064	+ .014	+.078	+ .166	+ .234	+ .200	+ .388	+ .404	+ .478	+ .611
1913	+ .662	+ .706	+ .677	+ .521	+.513	+ .298	+ .331	+ .500	+ .474	+ .486	+ .562	+ .633
1914	+ .617	+ .841	+ .778	+ .823	+.823	+ .870	+ .893	+ .771	+ .638	+ .602	+ .608	+ .462
1915	+ .401	+ .154	+ .144	+ .253	+.088	+ .025	− .048	+ .013	+ .136	+ .048	+ .024	+ .114
1916	+ .275	+ .179	+ .254	+ .244	+.273	+ .393	+ .342	+ .304	+ .216	+ .517	+ .597	+ .718
1917	+ .810	+ .937	+ .822	+ .740	+.788	+ .855	+ .873	+ .726	+ .738	+ .487	+ .338	+ .100
1918	− .098	− .078	− .105	− .447	−.830	−1.132	−1.273	−1.265	−1.253	−1.365	−1.401	−1.352
1919	−1.391	−1.425	−1.422	−1.051	−.697	− .561	− .412	− .349	− .441	− .240	− .274	− .115
1920	− .101	− .198	− .090	− .083	−.167	—.186						

cacy of the adjustment between marriages and economic conditions. A change in the latter is quickly reflected in the former.

The two other months which stand out prominently on the Chart are October and November of 1918, when the Cycle Figure registered −4.895 and −4.639 respectively. As we have said, such ranges of fluctuations are extremely rare. When they occur they indicate some violent disturbance.[1] These two months comprise those uncertain days, late in 1918, when the termination of the War hung in the balance. That this uncertainty about the turn in affairs should reflect itself in this manner is not strange.

In the month of April, 1917, when the United States declared war, the Cycle Figure rose to +2.677 from −0.003 in the previous month. For the next three months, May, June, and July, the Cycle Figure remained rather high at +2.100. Thereafter, the actual Cycle Figure was substantially above the line only for two months during the entire period of our connection with the War. These two months, moreover, were not consecutive. They were December, 1917, and August, 1918.

Turn for a moment to the curve in Chart 17, showing the Twelve-Months Moving Average, and follow its flow

[1] See the interesting table provided by Charlier, *op. cit.*, p. 20, giving limits, calculated from the mean, beyond which, on the average, one element of a statistical series will fall. He states there that one case of 100,000 items will fall beyond 4.4 times the Standard Deviation. Note for the present series that there are two such occurrences in (21 times 12) 252 items. This table is valid only where the Cycle Figures follow a normal distribution. Such a distribution of Cycle Figures from economic or bio-statistical data is rare. A study of the Cycle Figures of the Birth-Rate in this present study indicates that there is a pronounced tendency toward skewness in the positive direction. We have calculated Charlier's Coefficient of Skewness and Coefficient of Excess. We find them to be respectively +2538 and −.1855. We must note, however, that the calculation of these coefficients, built upon the calculation of higher moments, must be based upon a larger number of Cycle Figures. In the present case we deal with only 264. The results, however, suggest lines of further study.

from 1900 through 1920. Beginning in 1900, the curve is below the line, but only slightly below. Through 1901, its decline is gradual but continuous. It reaches its lowest point in this phase in September, 1902, when the curve registers −0.510.[1] Then, rising at a more rapid rate than the rate of decline, the curve touches the zero line in June, 1903. It hovers about that line for practically a year, and in October of 1904 starts a gradual decline. The decline continues until April, 1905, when the curve begins to go upward at a fairly rapid pace, crossing the line in October, 1905, and continuing upward throughout the year 1906. The highest point reached is January, 1907, when the figure is +0.888. Then the curve goes downward gradually until September of that year. Thenceforward, the rate of decline becomes greater. The downward flow continues and the curve crosses the line in February, 1908. It continues on its downward course through practically the whole of the year 1908. In the fall of that year, there is a slight rise, which continues until June of the following year. The rise, however, is not sufficient to carry the curve across the line. From June the curve begins another decline, which is rather gradual until March of the year 1910. Then a precipitous decline sets in, which culminates in June of that year, when the figure registered is −1.090. Then begins just as rapid a rise, which carries the curve across the line in April, 1911. Then begins a short recession so that for the first three months of the year 1912 the curve is below the line. A gradual rise begins immediately

[1] We need not mention that the earlier remarks about the importance of fluctuations of three times the Standard Deviation and more do not pertain to the figures secured by the Twelve-Months Moving Average. These figures are the result of a smoothing device. It is important to bear this in mind. The tacit assumption is made that fluctuations larger than the individual items on the curve reflecting the Twelve-Months Moving Average are the result of fortuitous circumstances.

which, except for a temporary drop in the late spring and early summer months of 1913, continues upward until July, 1914. Then the curve flows downward. After dipping below the line a mere trifle in July, 1915, it pursues a zigzag upward flow until February, 1917. Then the flow is downward, first at a slow rate, then at a very high rate. The curve crosses the line in January, 1918, and continues at this rapid rate until July, 1918, when the figure registered is −1.273. The decline then continues at a very much reduced pace until the lowest point of this phase is reached in February, 1919. The recovery is rapid for four months. Then the rate of recovery is slower. The curve is still below the line, however, in June, 1923.

This is the course of the Twelve-Months Moving Average since the year 1900. As we have seen above, the *actual* Cycle Figures show that only for the first four months after our entrance into the War were the number of marriages substantially above the line. Otherwise, they were, on the whole, low or below the line. We are led, therefore, to the conclusion that there were not many "war marriages."

This decline in the marriage-rate during war-times has been noted by other observers for various countries and various times. Ogle [1] has shown that during 1864, while Denmark was at war with Prussia, the marriage-rate fell from 15.00 to 11.13 per 1000 inhabitants; and that this was the lowest rate ever reached. The year following the close of hostilities showed recovery to 17.8, the highest point yet reached. During the war between Austria and Prussia, the marriage-rate for both countries showed similar fluctuations. The rate for Prussia fell from 18.2 to 15.6. The Austrian rate fell from 15.5 to 13.3, but at

[1] William Ogle, "On Marriage-Rates and Marriage-Ages," *Journal of the Royal Statistical Society*, vol. LIII (1890), p. 255.

the close of the war rose quickly to 19.3. Mayo-Smith[1] shows that the Franco-Pussian War brought it (the number of marriages which two years previously had been a little over 60,000) down to 40,707 in 1871. The cessation of the war brought it up to 52,045. Other students have alluded to this situation.[2]

The same phenomenon has been noted by careful students of American conditions. Willcox[3] has shown that the marriage-rate for Massachusetts was low during the Civil War; Crum[4] states that "as the outbreak of

[1] Richmond Mayo-Smith, "Statistics and Economics," *Publications of the American Economic Association*, vol. III (1888), pp. 53–54.

[2] Among others see Firks, *op. cit.*, p. 206: "Die Haufigkeit der Eheschliessungen steight nach Kriegen . . ."; L. Bodio, *Del Movimento della populazione Italia e in altri stati d'Europa* (1876), p. 137; Alexander von Oettingen, *Die Moral Statistik in ihre Bedeutung für eine christliche Socialethik* (2d ed., Erlangen, 1874), p. 93; Richmond Mayo-Smith, *Statistics and Sociology* (New York, 1895), p. 100. See especially George Elliott Howard, "The Matrimonial Barometer in Times of War and Peace," *Journal of Applied Sociology*, vol. VII, No. 3 (January–February, 1923), pp. 99–108: "Did full employment and higher wages backed by 'war-brides' patriotism more than offset in the marriage market the check of high prices? Such seems really to have been the case. It is held by thoughtful observers that the 'war-brides' sentiment was speeding up the marriage-rate. 'It is all to the good,' exclaims Ethel Colquhoun, that 'prudence and calculation have been flung for once to the winds and young hearts have come together under the shadow of war. Nature has had her way with many young folks in the last few months, and when we think how she has been starved and pinched and poked into the strait-jacket of worldliness in the last half-century, since love-in-a-cottage went out of fashion, it is good to think that she has come into her own again.'

"Be that as it may, there is reason to believe that the new labor conditions, due to the War, had much more to do with the rising marriage-rate than had the release of young hearts from the restraints of prudence and calculation under the impulse of military sentiment. It is well known that in the towns of both England and New England, when there is full employment for working women at fair wages, the rate of marriage is exceptionally high."

[3] Willcox, *loc. cit.*, pp. 76, 77; compare his study on "The Marriage-Rate in Michigan," *Journal of the American Statistical Association*, vol. IV (1895), p. 7.

[4] Crum. *loc. cit.*, p. 328. For the effect of war on marriage-rates, see Zehrfeld, "Die Kriegseheschliessungen," *Jahrbuch für Nationalökonomie und Statistik*, 3. F., vol. 50.

war causes a depression in the number of marriages by disturbing business, making calculation of the future difficult and uncertain, and engaging large numbers of men of marriageable age in military duties, so the termination of war is marked by a sudden increase in the number of marriages, due partly to the celebration of postponed marriage and partly to the renewal of industry and commerce."[1] To these two reasons for the quick recuperation of the marriage-rate Holmes[2] adds another. "The marriage-rate which is low in war time," he says, "goes up quickly after peace is resumed. Nature has endowed the female sex with a commendable partiality for the military hero."

[1] G. U. Yule seems to think that the rise in the marriage-rate is largely occasioned by the celebration of postponed marriages.

[2] Samuel J. Holmes, *The Trend of the Race* (New York, 1921), p. 211.

CHAPTER VI

THE NUMBER OF DIVORCE LIBELS

All of the preceding series have dealt with the City of Boston. In the instance of divorce cases, we deal with Suffolk County. In 1920 Boston formed 89.53 per cent of the total population of that county,[1] therefore, for all practical purposes, we are still dealing with the same population as heretofore. It must be noted, also, that we discuss the number of divorce libels filed and not the number of divorces granted. We have purposely selected the libels filed to escape the delay occasioned by legal procedure and practice. While it probably would have been possible to allow for this delay by the process of permitting the divorce curve to "lag," nevertheless such procedure would not have resulted in securing the same degree of homogeneity in the series pertaining to divorces as our method provides. Furthermore, while some divorce libels never culminate in divorces, it is more serviceable for the present purposes of this study to analyze the libels filed.[2]

[1] The population of Suffolk County at the Census of 1920 was 835,522. This total is divided as follows: Boston, 748,060; Chelsea, 43,184; Revere, 28,823; Winthrop, 15,455.

[2] "*Applications for Divorce.* The courts granted about three petitions out of every four filed. This proportion fluctuated considerably during the period 1900–22 the highest proportion of applications being granted in 1900 (89 per cent), and the lowest proportion in 1906 (67.1 per cent). During this entire period, 80.2 per cent of all applications were granted, .9 per cent were refused, and 18.9 per cent were dismissed. *Contested Cases.* Of the total number of applications for divorces during the twenty-three years from 1900 to 1922, only 10.2 per cent were contested. In 1922, of the 3733 applications for divorce, only 328, or 8.8 per cent, were contested, and of the 3277 divorces granted, 165, or 5 per cent, were contested. The proportion of contested cases is larger for divorces granted to the husband (6.6 per cent) than for those granted to the wife (4.5 per cent)." *Annual Report of the Vital Statistics of Massachusetts for Year ending December 31, 1922*, p. 174.

A. The Trend

Table 41 presents the number of divorce libels filed in Suffolk County, month by month, from January, 1900, through December, 1921. Chart 18 shows these data graphically. It will be noted that the month in which the

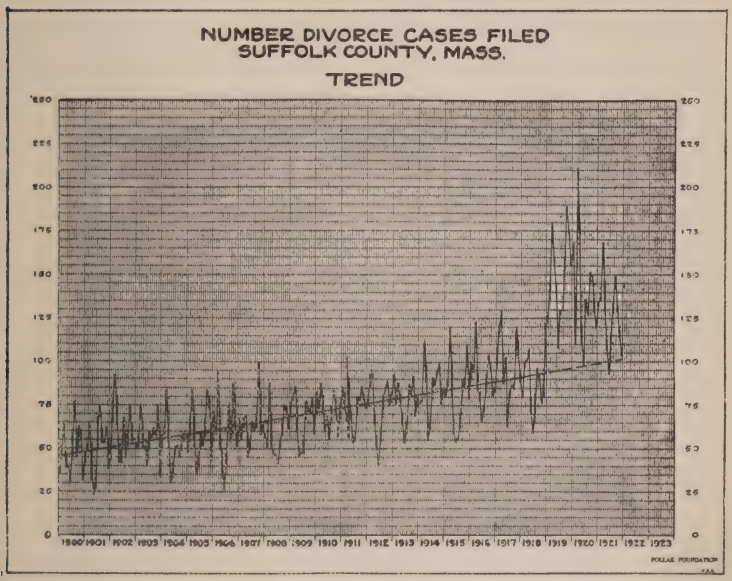

CHART 18

fewest divorce libels were filed was May, 1901, when only 23 such libels were filed. June, 1906, is close to the earlier low point with 27 cases filed. The month in which the largest number of divorce libels was filed was March, 1920, during which month 212 cases were filed in the court. October, 1919, witnessed the filing of 188 cases and March of the same year is close by with 180 cases. There is, then, a very wide gap between the lowest month of the series and the highest month. The heaviest month is 9.22

Table 41. Divorce Cases Filed in Suffolk County

Year	January	February	March	April	May	June	July	August	September	October	November	December
1900	36	48	64	39	39	30	51	77	45	63	58	32
1901	47	51	64	37	23	29	66	74	54	53	62	39
1902	50	79	92	65	42	42	68	45	58	75	55	56
1903	50	52	76	51	51	40	60	56	62	57	75	35
1904	57	60	84	51	31	34	51	52	46	60	55	59
1905	48	65	84	54	35	42	60	52	64	84	77	46
1906	72	59	96	55	43	27	46	77	55	88	65	52
1907	68	55	68	69	46	49	66	61	63	100	58	64
1908	57	50	88	52	47	47	42	56	60	76	74	62
1909	75	82	86	63	45	48	47	78	71	71	80	59
1910	83	74	88	76	61	69	56	73	84	75	57	76
1911	85	77	103	55	66	53	55	80	78	86	81	74
1912	75	93	93	65	54	40	59	81	84	90	76	80
1913	93	76	88	77	66	53	63	88	82	92	69	79
1914	76	78	112	87	55	64	91	87	93	99	76	84
1915	82	88	120	82	58	54	56	65	89	86	110	79
1916	100	94	123	85	81	67	73	91	103	96	81	86
1917	106	122	129	88	102	63	83	87	85	119	105	91
1918	80	101	101	107	72	59	78	96	90	77	82	122
1919	124	140	180	155	138	108	129	130	159	188	171	155
1920	168	111	212	161	111	98	137	127	151	148	130	119
1921	134	137	168	133	107	93	114	135	149	129	117	103

times the lightest month; in the case of marriage, the highest month of the series was 4.73 times the lightest month.[1]

It will easily be noted in Chart 18 that the number of divorce libels filed has been increasing steadily since 1900. It will be noted, also, that late in the year 1918 a change in the growth feature occurs. For this reason, in calculating the trend line which is shown as the straight line in the Chart, we have used the span of years 1900 through 1918. Beyond that year we have extrapolated the trend line.[2] The portion so extrapolated is shown by the broken line. Later in this study we shall have something further to say concerning this sudden change in the long-time trend. At this point we content ourselves by noting that this change may indicate a permanent change in the divorce situation; on the other hand, this change may be only a temporary situation. The equation to the trend line is $y = .213\,x + 69.382$. The lowest ordinate of trend is January, 1900, with 45.100; the highest point, December, 1921, is 101.119. This represents an increase in trend of 124.21 per cent. In order to compare the increase in trend of divorce with the increase in trend of marriage we have calculated the increase in the divorce trend from 1900 through December, 1920. That increase was 118.54 per cent. Compare this with the increase in trend of marriages of 41.02 per cent. We mentioned earlier that the population of Boston was 33.37 per cent larger in 1920 than in 1900. This we compared with an increase in the marriage

[1] In this connection, note the fact that the Coefficient of Disturbancy as given by Charlier for Divorces is 18.81 ± 2.70 as compared with 5.49 ± 0.79 for marriages. (Charlier, *op. cit.*, p. 43.)

[2] While for the period under survey a straight line "fits" the data very well, for longer periods such a straight line will not suffice. Dr. Ogburn and Miss Thomas use a parabola, concave upward, for the divorce rates in certain States for the period 1870 through 1906. The equation to the curve is $y = 46.685 + 1.542\,x + 0.0289\,x^2$. (*Loc. cit.*, p. 334.)

trend of 41.02 per cent during the same period. The population of Suffolk County was 36.65 per cent larger in 1920 than in 1900; during this same time the trend of divorce libels filed increased by 124.21 per cent, or 3.39 times as fast as did the population. During this same period the marriages increased 1.23 more quickly than the population of Boston. In other words, the divorce libels filed in Suffolk County have increased almost three times as fast (2.75 times) as have marriages during the twenty-one years, 1900 through 1920.

When we turn to the divorces *granted* in Massachusetts since 1870, we find the following interesting tabulation:

DIVORCES IN MASSACHUSETTS

YEAR	PER 100,000 POPULATION	YEAR	PER 100,000 POPULATION
1870	23.67	1910	56.44
1875	33.29	1915	62.35
1880	29.72		
1885	34.09	1916	60.9
1890	32.30	1917	68.6
1895	43.67	1918	60.2
1900	46.05	1919	66.1
1905	57.63	1920	94.7

It will be noted that there has been a steady increase in the divorce-rate per 100,000 of the population. It is true that there are temporary recessions, as in the years 1880 and 1916. Nevertheless, the rise has not faltered much. This is true even though we calculate the refined divorce-rate for 100,000 of the married population. In that case, the rate for 1900 is 123; for 1910, 146; for 1915, 157.0. Notice, too, the exceptional rise in the year 1920. We reserve comment upon this feature of the curve for Massachusetts for future pages. This same increase is noted in the combined divorce-rates from 1870 through 1906 for the following thirteen States: Connecticut, Indiana,

Iowa, Maine, Massachusetts, Michigan, New Hampshire, Ohio, Rhode Island, South Dakota, Utah, Vermont, Wisconsin.[1]

NUMBER OF DIVORCES GRANTED

YEAR	PER 100,000 POPULATION	YEAR	PER 100,000 POPULATION
1870	28	1890	53
1871	29	1891	55
1872	30	1892	56
1873	31	1893	56
1874	32	1894	55
1875	32	1895	58
1876	33	1896	61
1877	34	1897	62
1878	34	1898	65
1879	35	1899	69
1880	39	1900	73
1881	40	1901	79
1882	42	1902	78
1883	43	1903	81
1884	42	1904	81
1885	42	1905	82
1886	44	1906	86
1887	47		
1888	48		
1889	52		

There can be no doubt that the divorce-rate is increasing in the United States.[2] The same increase has

[1] Ogburn and Thomas, *loc. cit.*, p. 326.

[2] See the following for further reference upon the growth of the divorce-rate: Walter F. Willcox, "The Divorce Problem: A Study in Statistics," *Columbia College Studies*, vol. I, No. 1 (New York, 1891; 2d ed., 1897); *ibid.*, "A Study in Vital Statistics," *Political Science Quarterly*, vol. VIII (1893), pp. 69–96; Samuel W. Dike, "Some Aspects of the Divorce Question," *Princeton Review* (N.S.), vol. XIII (1884), pp. 169–90; *ibid.*, "On Divorce," *Publications of American Statistical Association*, vol. I (1889), pp. 206–14; *ibid.*, "Statistics of Marriage and Divorce," *Political Science Quarterly*, vol. IV (1889), pp. 592–614.

been noted for European countries.[1] We are concerned, then, with a phenomenon which is world-wide.[2]

B. Seasonal Fluctuations

We turn next to a discussion of the seasonality in divorce. Is there such a feature? We have met with no discussion of this question in the voluminous literature on the subject.

Table 45 shows the Seasonal Fluctuations in the number of divorce libels filed. Graphically, these fluctuations are shown in Chart 19. It will be noted immediately that there is a decided seasonal factor to the divorce situation.

[1] The report of Commissioner Wright provides data for most of the European states. These data have been supplemented by Émile Yvernes, in the *Journal de la Société de Statistique de Paris*, November, 1897. See especially, von Firks, *op. cit.*, pp. 234–42. See the monumental work "Marriage and Divorce in the United States, 1867–86," *First Special Report of the Commissioner of Labor*, Carroll D. Wright, Commissioner, Washington, 1889; revised, March 7, 1891; second edition, 1897. These data for Europe were supplemented and partially brought up to date by Émile Yvernes, in the *Journal de la Société de Statistique de Paris*, November, 1897. See also the Special Reports of the Census Office: *Marriage and Divorce, 1867–1906* (Washington, 1909), Part I. J. Müller, "Statistische Uebersicht über die Ehescheidungen in den wichtigsten Kulturländern," *Jahrbuch für Nationalökonomie*, 3 F., vol. 47; F. Kühnert, "Die Ehescheidungsbewegung in Preussen in den Jahren 1895–1905," *Zeitschrift des Königlichen Preussische Statistische Landesamts* (1907); A. Bosco, *I Divorzi e le separazioni personali dei conjugi* (Rome, 1903); L. Ehrler, "Zunahme der Ehescheidungen in den Deutschen Grossstädten," *Jahrbuch für Nationalökonomie und Statistik*, 3 F., vol. 62; Conrad, *op. cit.*, pp. 143–50. For Charts showing the growth of the divorce-rate in the United States, see Diagram 5, page 14, of the Census Report. This has been reprinted in Maurice Parmelee, *Poverty and Social Progress* (New York, 1917), p. 207; also, see F. W. Blackmar and J. L. Gillin, *Outlines of Sociology* (New York, 1916), pp. 138–56; for data on foreign countries, see the second *United States Report*, chap. 5, pp. 391–520; see especially, G. von Firks, *op. cit.*, pp. 234–42; George E. Howard, "Social Control of the Domestic Relations," *American Journal of Sociology*, vol. XVI (1911), pp. 805–17; J. P. Lichtenberger, "Divorce: A Study in Social Causation," *Columbia University Studies*, vol. XXXV (New York, 1909).

[2] Professor East makes an interesting observation concerning the relationship between the possibility of reducing the divorce-rate through a wider distribution of knowledge of restriction of the birth-rate, *op. cit.*, pp. 336–37. Also, note chapters 32 and 33 in Westermarck, *op. cit.*

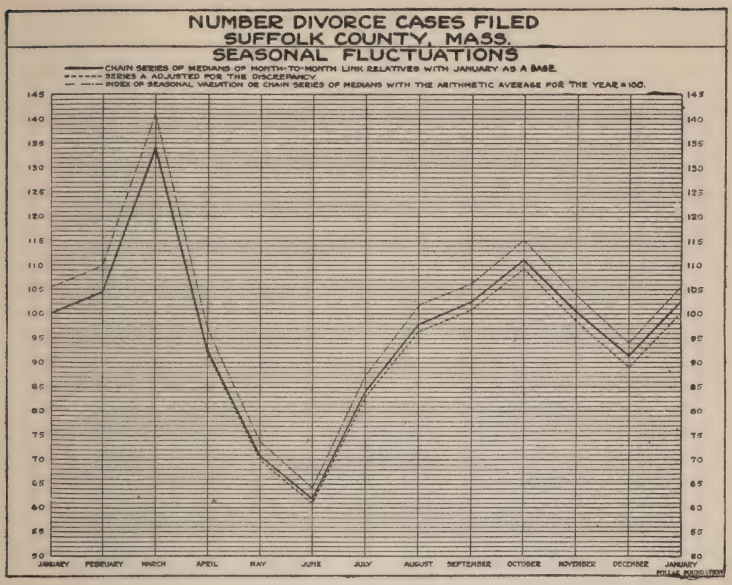

CHART 19

This feature has not been noted earlier, largely because studies have more particularly dealt with the number of divorces granted, rather than with the number of applications for divorce which have been filed. It will be noted that there are two maximal points, March and October. June is the lowest month; December, too, is a low point. The heaviest month, March, registers 140.91; October shows 115.13. There is no question, whatsoever, then, that the round of the seasons occasions wide variations in the number of divorce libels filed in Suffolk County.

In an attempt to arrive at suggestions concerning this rather unexpected seasonality in the divorce situation, we have correlated these seasonal variations with the seasonality of marriages and the seasonality of unemployment.

Table 45. Seasonal Indexes, Number of Divorce Cases Filed Monthly

	Jan. / Dec.	Feb. / Jan.	March / Feb.	April / March	May / April	June / May	July / June	Aug. / July	Sept. / Aug.	Oct. / Sept.	Nov. / Oct.	Dec. / Nov.	Jan. / Dec.
Medians of Link Relatives.....	112.30	104.35	128.40	69.20	76.35	87.50	135.70	116.40	104.95	108.15	90.00	90.80	112.30
Chain Series	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.
With January as 100.....	100.00	104.35	133.98	92.71	70.78	61.93	84.03	97.81	102.41	111.02	100.58	91.33	102.56
Adjusted for Discrepancy.....	100.00	104.14	133.56	92.08	69.94	60.88	82.77	96.34	100.73	109.13	98.48	89.02	100.00
With Arithmetic Average as 100...	105.50	109.87	140.91	97.15	73.79	64.23	87.32	101.64	106.27	115.13	103.90	93.92	105.50

The following are[1] the coefficients secured by allowing the seasonality in divorces to lag behind the seasonal variations in marriage.

COEFFICIENTS OF CORRELATION BETWEEN SEASONAL FLUCTUATIONS IN MARRIAGES AND DIVORCES

Synchronous	−.4134
Lag 1 month	−.0833
Lag 2 months	+.1242
Lag 3 months	+.2451
Lag 4 months	+.5619
Lag 5 months	+.3331
Lag 6 months	−.0928
Lag 7 months	−.4089
Lag 8 months	−.3628
Lag 9 months	+.3225
Lag 10 months	−.1003
Lag 11 months	−.1253
Synchronous	−.4134

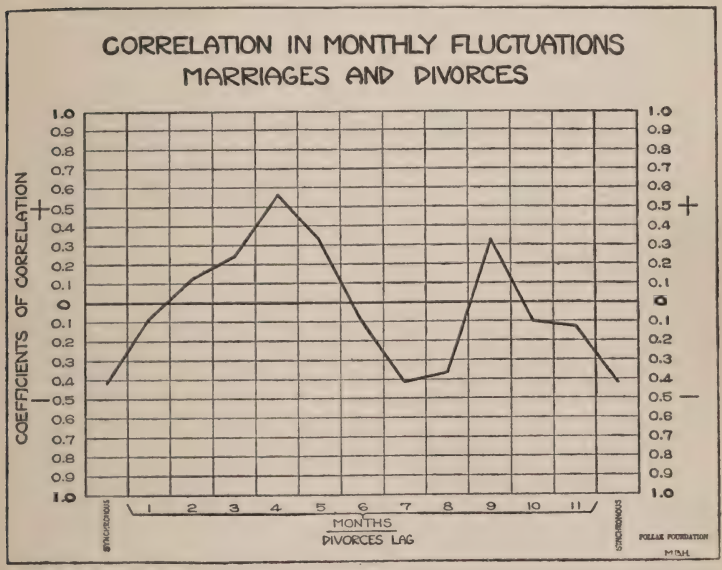

CHART 20

[1] The Standard Deviation of the Seasonal Indexes is 18.8409.

These findings appear in Chart 20. It will be noted that at two points we secure sensible coefficients. Those two points are (1) when the seasonal variations in divorce lag four months behind the seasonal fluctuations in marriage and (2) when the two curves are concurrently paired. In the former instance, we secure a coefficient of +.5619; and in the latter case, a coefficient of −.4134.[1] The interpretation of these coefficients declares that the seasonal fluctuations in the number of marriages is closely related to the number of divorces four months later. Furthermore, the relationship is a positive one, that is, the greater the number of marriages, the larger the number of divorces.[2] This is not so very strange since a marriage may be declared void in Massachusetts in consequence of violation of the provisions of the marriage laws; that is, a separation may be granted because of the demonstration of conditions obtaining at the time of, or previous to, the alleged marriage which shows that there never was a

[1] "There is probably also some degree of positive correlation between the marriage and divorce rates, though because of irregularities in the lag, it cannot easily be given a numerical expression." (Davies, *loc. cit.*, p. 114.)

[2] Causes for which divorce from the bonds of matrimony may be granted in Massachusetts under the provisions of sections 1 and 2, chapter 208, General Laws, are as follows:

1. Adultery.
2. Impotency.
3. Desertion for three consecutive years next prior to the filing of the libel.
4. Gross and confirmed habits of intoxication caused by the voluntary and excessive use of intoxicating liquor, opium, or other drugs.
5. Cruel and abusive treatment.
6. Neglect to provide.
7. Sentence to imprisonment at hard labor for five years or more.

A marriage may be declared void in consequence of violation of the provisions of the laws concerning marriage; that is, a separation may be granted because of the demonstration of conditions obtaining at the time of, or previous to, the alleged marriage, which show that there never was a legal marriage. (*Annual Report of the Vital Statistics of Massachusetts for Year Ending December 31, 1922*, p. 173.)

legal marriage. The discovery of these facts and the preparation of the legal documents would require just about four months. Note, likewise, that the coefficients for a period of lag of two, three, and five months are also positive.

The following tabulation shows the findings when we correlate the seasonal fluctuations in divorce with seasonality in unemployment.

COEFFICIENTS OF CORRELATION BETWEEN SEASONAL FLUCTUATIONS IN DIVORCE AND UNEMPLOYMENT

Synchronous	+.2466
Lag 1 month	+.2707
Lag 2 months	+.1526
Lag 3 months	−.1655
Lag 4 months	−.6610
Lag 5 months	−.7692
Lag 6 months	−.4856
Lag 7 months	+.0914
Lag 8 months	+.4136
Lag 9 months	+.4396
Lag 10 months	+.3228
Lag 11 months	+.0961
Synchronous	+.2466

These facts are shown graphically in Chart 21. It will be noted immediately that the most significant coefficients are secured when the curve for seasonality in divorce lags behind the curve for unemployment four and five months. We then secure coefficients, respectively, of −.6610 and −.7692. The latter of these coefficients is the highest secured in this entire series of correlations of seasonal variations. The one which is closest to it is the one secured by correlating the curves of marriage and birth (see Chart 3) where we found a coefficient of +.7109 when the curve representing seasonal fluctuations in the birth-rate lags nine months behind the curve representing

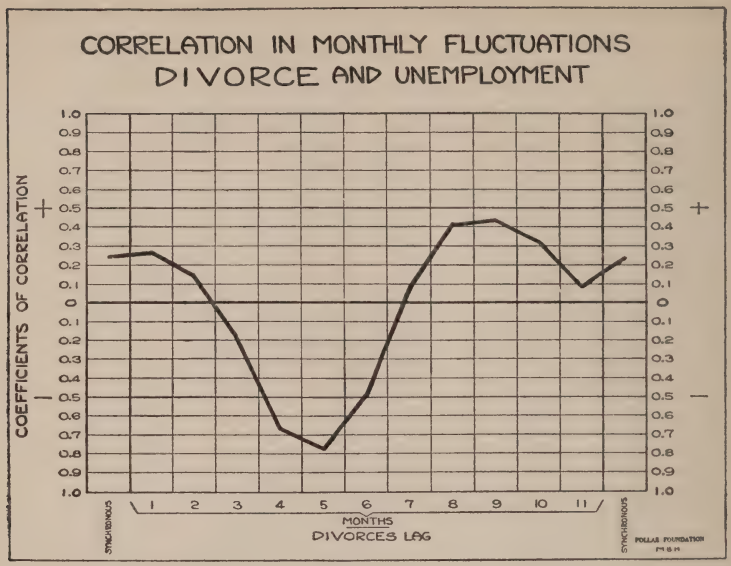

CHART 21

seasonality in marriage. We have just mentioned the high coefficient secured in pairing divorce with unemployment. The sign of the coefficient was negative, so that by changing the sign we can speak of *employment* rather than unemployment. This coefficient shows that seasonal fluctuations in divorces vary *directly* with the seasonal fluctuations in employment five months earlier. The interesting feature, further, is that unemployment does not seem to be paired with a high variation in divorce. This may or may not indicate a direct causal connection. We call attention, at this point, simply to the fact.[1]

[1] We have correlated by the method of partial correlation the three variables, marriage, divorce, and unemployment. The period of lag was four months. When we pair marriage and divorce, and keep the effect of unemployment constant, we arrive at a coefficient of +.5945, which is slightly larger than the coefficient secured by correlating only marriage and divorce. When we correlated divorce and unemployment, keeping constant the

Before we leave the seasonal factor in divorce, we may note that without any doubt the secondary peak in October is partially the result of influences which, while seasonal, are not of prime interest in this study. We refer to the fact that the filing of a divorce libel in the months of July, August, and September will not secure, in all likelihood, an earlier hearing in Court than those filed in the month of October. The summer season, in addition, brings vacations to lawyers. We are urged to the conclusion, therefore, that the October peak is at least in part the result of the cumulated cases due to these peculiarities of legal procedure. While we have no way of demonstrating the fact, we believe that this effect is not very substantial, and that this October peak is, in part, a definite seasonal fluctuation.

C. Cyclical Fluctuations

Tables 47 and 48 show the cyclical fluctuations in the number of divorce cases filed in Suffolk County since January, 1900. These data are shown pictorially in Chart 22. It will be noted at once that the Cycle Figures present very little of "the ebb and flow" which we recognize as representing cyclical fluctuations, with the exception of two portions of the Chart. These two segments of the Chart are (1) the years 1902, 1903, and 1904, and (2) the years 1919, 1920, and 1921. In the rest of the months under survey, the cyclical fluctuations range so evenly on both sides of the zero line that even the Twelve-Months Moving Average does not reflect sufficient "ebb and

seasonal variation in marriage, we arrived at the very high coefficient of −.9428. The coefficient without "marriage constant" was −.6610. Now this seems to indicate that unemployment and divorce are not fluctuating in the same direction; in other words, when the seasonal variation of unemployment is high, this is apt to be followed four months later by a low seasonal variation in divorce.

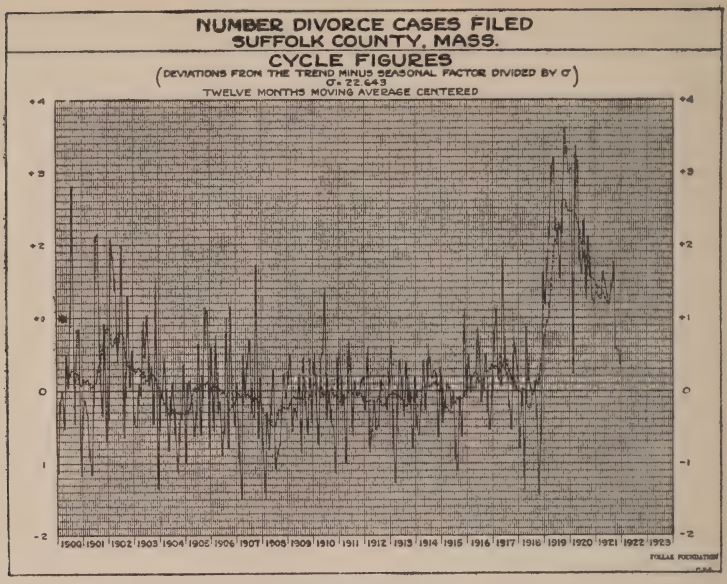
NUMBER DIVORCE CASES FILED
SUFFOLK COUNTY, MASS.
CYCLE FIGURES
(DEVIATIONS FROM THE TREND MINUS SEASONAL FACTOR DIVIDED BY σ)
σ = 22.643
TWELVE MONTHS MOVING AVERAGE CENTERED
+4
+3
+2
+1
0
-1
-2
1900 1901 1902 1903 1904 1905 1906 1907 1908 1909 1910 1911 1912 1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923

CHART 22

flow," which might even suggest cycles in the divorce situation.[1] We content ourselves, here, by noting merely that subsequent to the year 1904 the fluctuations do not seem to suggest anything even remotely akin to the business cycle. When we come to the fall of 1918, however, things begin to happen. The curve reflecting the Twelve-Months Moving Average takes a sudden, rapid, and emphatic upward turn. From registering zero in July of that year, the curve reaches 2.610 for September and October of 1919. This is the highest point registered by the Twelve-Months Moving Average in any of the series analyzed in this study. The curve then declines gradually, but is still far above the line for the year 1921, when we closed the analysis.

[1] The Standard Deviation of the Cycle Figures is 22.643.

TABLE 47. CYCLE FIGURES, DIVORCE CASES FILED IN SUFFOLK COUNTY

YEAR	January	February	March	April	May	June	July	August	September	October	November	December
1900	−1.131	− .171	− .013	− .528	+ .496	+ .034	+1.003	+2.810	− .448	+ .834	+ .840	−1.170
1901	− .309	− .135	− .341	− .904	−1.162	− .209	+2.110	+2.150	+ .147	− .363	+ .920	− .704
1902	− .270	+2.070	+1.811	+1.360	+ .381	+ .786	+1.975	− .647	+ .246	+1.271	+ .057	+ .547
1903	− .478	− .511	+ .088	− .077	+ .942	+ .445	+1.043	+ .064	+ .341	− .488	+1.460	−1.343
1904	− .110	− .082	+ .431	− .263	− .826	− .170	+ .118	− .444	−1.133	− .448	− .358	+ .362
1905	− .995	+ .094	+ .136	− .215	− .627	− .318	+ .622	− .617	+ .036	+1.135	+1.076	− .780
1906	+ .596	− .558	+ .754	− .311	− .158	− .900	− .566	+ .994	− .794	+1.151	− .008	− .492
1907	+ .110	−1.009	−1.491	+ .488	− .074	+ .340	+ .684	− .302	− .388	+1.715	− .660	+ .180
1908	− .816	−1.492	− .323	− .820	− .132	+ .277	−1.081	− .806	− .749	− .166	+ .230	− .107
1909	+ .199	+ .493	− .672	− .241	− .375	+ .229	− .862	+ .462	− .193	− .608	+ .442	− .452
1910	+ .517	− .237	− .756	+ .426	+ .505	+1.405	− .412	− .023	− .434	− .528	−1.135	+ .448
1911	+ .464	− .217	− .040	−1.001	+ .677	+ .321	− .612	+ .130	− .087	− .041	+ .159	+ .180
1912	− .287	+ .571	− .836	− .537	− .149	− .546	− .470	+ .148	+ .089	+ .034	− .278	+ .368
1913	+ .614	− .577	−1.282	+ .024	+ .421	+ .109	− .359	+ .379	− .171	− .023	− .800	+ .180
1914	− .509	− .612	− .137	+ .427	− .287	+ .616	+1.012	+ .179	+ .284	+ .206	− .652	+ .304
1915	− .437	− .215	+ .092	+ .024	− .220	− .001	− .935	−1.112	− .087	− .631	+1.100	− .076
1916	+ .478	− .038	+ .057	+ .037	+ .861	+ .561	− .169	+ .104	+ .498	− .263	− .531	+ .145
1917	+ .632	+1.111	+ .185	+ .068	+1.784	+ .264	+ .225	− .223	− .533	+ .741	+ .526	+ .278
1918	− .791	+ .027	−1.400	+ .864	+ .190	− .010	− .012	+ .095	− .411	−1.430	− .707	+1.615
1919	+1.180	+1.730	+2.220	+3.060	+3.190	+2.190	+2.150	+1.560	+2.680	+3.600	+3.250	+2.990
1920	+3.060	+ .227	+3.450	+3.050	+1.790	+1.614	+2.340	+1.245	+2.110	+1.581	+1.245	+1.183
1921	+1.333	+1.277	+1.245	+1.630	+1.471	+1.282	+1.175	+1.428	+1.843	+ .568	+ .535	+ .353

TABLE 48. TWELVE-MONTHS MOVING AVERAGE OF CYCLE FIGURES, DIVORCE CASES FILED IN SUFFOLK COUNTY

YEAR	January	February	March	April	May	June	July	August	September	October	November	December
1900						+ .213	+ .281	+ .284	+ .257	+ .228	+ .088	+ .067
1901	+ .160	+ .105	+ .154	+ .054	+ .061	+ .100	+ .103	+ .370	+ .455	+ .647	+ .775	+ .856
1902	+ .846	+ .613	+ .621	+ .757	+ .694	+ .798	+ .781	+ .564	+ .422	+ .303	+ .343	+ .321
1903	+ .243	+ .303	+ .311	+ .165	+ .281	+ .124	+ .155	+ .190	+ .218	+ .203	+ .056	+ .047
1904	− .072	− .114	− .197	− .234	− .385	− .243	− .317	− .303	− .327	− .323	− .307	− .318
1905	− .277	− .291	− .193	− .062	+ .057	− .037	+ .094	+ .040	+ .092	+ .084	+ .123	+ .074
1906	− .024	+ .109	+ .041	+ .042	− .047	− .024	− .064	− .102	− .289	− .222	− .216	− .112
1907	− .008	− .116	− .082	− .035	− .090	− .034	− .111	− .151	− .054	− .163	− .168	− .172
1908	− .320	− .363	− .391	− .465	− .493	− .498	− .414	− .249	− .277	− .229	− .249	− .254
1909	− .235	− .129	− .083	− .120	− .103	− .131	− .105	− .166	− .172	− .117	− .044	− .054
1910	+ .091	+ .051	+ .031	+ .037	− .094	− .018	− .023	− .021	+ .038	− .081	− .066	− .157
1911	− .173	− .161	− .131	− .091	+ .016	− .005	− .068	− .002	− .068	− .031	− .099	− .171
1912	− .159	− .158	− .143	− .137	− .173	− .157	− .082	− .178	− .223	− .177	− .129	− .066
1913	− .057	− .038	− .060	− .064	− .108	− .123	− .217	− .220	− .125	− .091	− .150	− .108
1914	+ .006	− .010	+ .027	+ .046	+ .059	+ .069	+ .075	+ .108	+ .127	+ .093	+ .099	+ .048
1915	− .114	− .221	− .253	− .323	− .169	− .208	− .132	− .117	− .120	− .119	− .029	+ .018
1916	+ .082	+ .183	+ .232	+ .263	+ .126	+ .145	+ .158	+ .253	+ .264	+ .267	+ .344	+ .319
1917	+ .352	+ .324	+ .238	+ .322	+ .411	+ .422	+ .302	+ .221	+ .080	+ .147	+ .014	− .008
1918	− .028	− .002	+ .008	− .172	− .275	− .164	± .000	+ .142	+ .074	+ .257	+ .506	+ .690
1919	+ .870	+ .989	+1.247	+1.668	+1.993	+2.110	+2.270	+2.150	+2.610	+2.610	+2.490	+2.450
1920	+2.470	+2.430	+2.390	+2.230	+2.060	+1.906	+1.760	+1.850	+1.668	+1.545	+1.525	+1.495
1921	+1.393	+1.411	+1.390	+1.305	+1.246	+1.179						

This portion of the Chart stands out in such bold relief compared with the balance of the Chart that we suggest certain explanations for this remarkable bulge. We mentioned earlier in this chapter that the trend line was extrapolated for the years 1919, 1920, and 1921. This had been done because a cursory inspection of Chart 18 showed that for those years certain forces had been at work which had changed the number of divorce libels filed. Now that change in trend might have indicated a permanent condition; on the other hand, those years might be abnormal ones, and at their termination the trend might again resume its former slope, or essentially so.[1] The conformation of the curve reflecting the Twelve-Months Moving Average shows that these years, 1919, 1920, and 1921, reflect only a temporary situation so far as the trend is concerned, and we are warranted in having extrapolated the trend for that period.

It might be suggested, on the other hand, that this bulge for the three-year period, 1919–21, is the result of a sudden increase in the number of marriages. One look at Charts 14 and 17 will indicate that marriages did not increase disproportionately for the years in question, or even for the few years preceding. While there is a small and temporary rise during 1917, it is not sufficient to account for the excessive bulge in question.

Another explanation for the bulge might indicate that it represented divorces of war-time marriages. A glance at Chart 17 and the discussion of the cyclical fluctuations in marriage will indicate that the marriages during the War were few. This, we mentioned earlier, was corroborated by other investigators. The large number of

[1] In calculating trends for the War and post-War period, one must tread one's way most carefully, taking little for granted, and always bearing in mind the actual data presented and conditions reflected.

divorces during the years 1919, 1920, and 1921 cannot be the result substantially of a large number of War marriages.

The only reasonable explanation of the bulge which we have to offer is that it is the result of War *conditions* and *post-War psychology*. We believe that other explanations can successfully be ruled out. We have ruled out the possible explanation that the extrapolation of the trend might be responsible for the rise. We have ruled out the explanation that the bulge may result from cyclical fluctuations in business, since, for practically the entire period under review, such fluctuations do not seem to have affected the cyclical fluctuations in divorce. We have ruled out the explanation that the War marriages are responsible. We think, therefore, that the unrest and uncertainty in the world, subsequent to the War, is accountable for the sudden rise in the number of divorces. The War certainly uprooted people; it jerked them from their accustomed modes of living; it brought new thoughts and new contacts; it broadened many lives. It is not strange, then, that all of these forces shall have affected even the closest of bonds. Lord Birkenhead has also suggested that the social upheaval of war has in nineteen cases out of twenty been responsible for the number of petitions for the dissolution of the marriage bond.[1]

[1] Westermarck, *op. cit.*, vol. III, p. 369, footnote 6. Westermarck goes on to say that it was pointed out "in an article in the *Times* for June, 1921, that the facilities afforded to suitors under Poor Persons Rules must also have something to do with the increase in question, since 'the figures which are published day by day indicate that a considerable proportion of the work of the Divorce Court is the hearing of such suits.'" Westermarck here refers to the fact that the increase in the divorce-rate in England is largely due to the statute which reduced very materially the cost of divorce procedure in England.

CHAPTER VII

SUMMARY OF PART ONE

In this chapter we summarize some of the outstanding findings of Part One; in addition, we compare certain of these phenomena and their variations with other occurrences.

A. The Trend

We have noted that the trend in the birth-rate, stillbirth-rate, and the death-rate has been downward. We found that for the birth-rate, the decline in trend for the period 1900 through 1921 was 8.66 per cent. During the same period, the stillbirth-rate declined 9.54 per cent; for the death-rate the decline registered during that span of years was 36.51 per cent. We found, further, that these long-time tendencies were not unique either to Boston, to Massachusetts, or to the United States; they are well-nigh universal phenomena. When we turned to marriages and divorces, we found that the trend was decidedly upward. For the period 1900 through 1920, the trend in marriages increased 41.02 per cent; for divorces filed the trend increased 118.54 per cent. We found, further, that the population had increased during those same years 33.37 per cent. This means that, compared with the population, marriages and divorces have increased faster than the population; marriages increased 22.92 per cent more rapidly than the population: the number of divorces filed increased 3.39 times as fast as did the population. We found, further, that divorces increased about 2.75 times as fast as did marriages.

B. Seasonal Fluctuations

We noted that there was a strong seasonal fluctuation in the birth-rate, death-rate, marriages,[1] and divorces. We found, likewise, hints of seasonality in the stillbirth-rate. Table 51 summarizes the seasonal indexes of all of

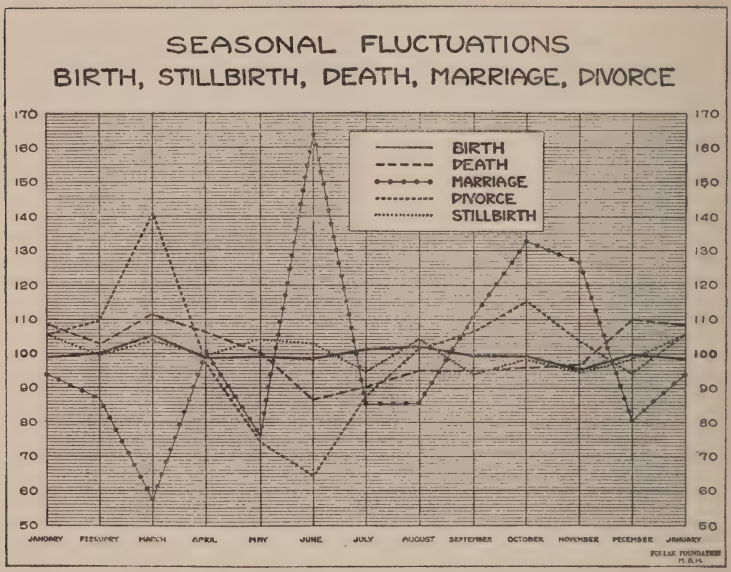

CHART 23

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[1] We recall the fact that for the birth-rate, we found two peak months — that is, March and August. For the twenty years, 1876–95, the monthly ratio of births in Massachusetts was as follows:

MONTHS	MONTHLY RATIO	MONTHS	MONTHLY RATIO
January	95.6	July	104.1
February	98.6	August	106.6
March	98.0	September	104.4
April	94.9	October	101.3
May	94.0	November	101.5
June	98.4	December	102.7

During that time, however, marriages were more frequent in September, October, and November, rather than in June, as now. (*Vital Statistics of Massachusetts, 1856–95*, Public Document, No. 34, p. 736.)

TABLE 51. SEASONAL FLUCTUATIONS IN BIRTH-RATE, STILLBIRTH-RATE, DEATH-RATE, MARRIAGE, AND DIVORCE

VARIATE	January	February	March	April	May	June	July	August	September	October	November	December	January
Birth-rate.....	98.824	99.91	105.50	98.79	99.34	98.81	101.50	102.44	99.67	99.52	95.61	100.09	98.824
Stillbirth-rate.....	105.341	99.317	103.840	99.413	104.540	103.138	94.968	104.177	94.030	98.328	94.857	98.053	105.341
Death-rate.....	108.65	103.10	111.41	106.27	100.54	86.87	90.15	95.00	95.03	96.01	96.60	110.23	108.65
Marriage.....	93.66	87.10	57.48	99.97	76.28	163.80	85.20	85.60	110.50	132.94	126.84	80.62	93.66
Divorce.....	105.50	109.87	140.91	97.15	73.79	64.23	87.32	101.64	106.27	115.13	103.90	93.92	105.50

these statistical series. The data of this Table are shown as Chart 23.

It will be readily noted that certain months represent times of great stress in society.[1] March is the heaviest month for births, deaths, and divorce cases. It is lightest for marriages. June is the heavy month for marriages — it is lightest for divorce cases and deaths. October, also, is a heavy month for marriage and divorce — holding second rank for each.

It seems strange that seasonality in these statistical series which reflect human activities has occasioned very little careful analysis.[2] Most of the attention that has been given to the connection between various statistical observations dealing with these phenomena has been applied to crude series.[3] We have felt, therefore, that some further attention to the correlation of these seasonal indexes might suggest certain relationships. We, therefore, correlated the various seasonal indexes, both among themselves, and for the seasonal variation in unemployment. The following are the pairings utilized in this process:

1. Correlation between the birth-rate and marriages.

[1] To simplify Table 51, we present the following tabulation of the same material by ranks.

Variate	Rank											
	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Birth-rate	9	5	1	11	8	10	3	2	6	7	12	4
Death-rate	3	5	1	4	6	12	11	10	9	8	7	2
Marriages	6	7	12	5	11	1	9	8	4	2	3	10
Divorces	5	4	1	8	11	12	10	7	3	2	6	9
Stillbirth-rate	1	7	4	6	2	5	10	3	12	8	11	9

Interpretation of the table in this manner must be cautious, as the distribution of the indexes is not rectangular.

[2] With the exception of marriages and death-rates.

[3] See footnote 1, page 6.

2. Correlation between the birth-rate and unemployment.
3. Correlation between the birth-rate and death-rate.
4. Correlation between marriage and unemployment.
5. Correlation between marriage and divorce.
6. Correlation between divorce and unemployment.

Table 52 shows the coefficients of correlation found by allowing one of these paired variables to lag behind the other. These coefficients have been charted and appear in summary fashion in Chart 24. It should be noted that when these coefficients of correlation, for various degrees of *lag* or *lead*, are arranged in fairly definite *periods* (as, for example, the coefficients for Divorce and Unemployment), the coefficient merits a high degree of confidence.[1]

It will be recalled that we found that the maximum degree of correlation between the birth-rate and marriages was secured when we paired the curves so that we linked marriages with *conceptions* (or, in other words, where we allowed the seasonal indexes of the birth-rate to lag nine months), and that in this case the coefficient was high and positive. We showed that when we correlated the seasonal variations in the birth-rate and unemployment, we found that the maximum coefficient of correlation occurred when the birth-rate lagged *ten* months behind the curve of seasonal variations in unemployment. In that case the coefficient was also rather high, but negative. This coefficient indicated that the birth-rate was high when the seasonal variation in unemployment was low, and conversely. We suggested that the seasonality in marriages may be the modern response to an earlier pairing season.[2]

[1] An example of irregular distribution is the correlation of Birth-Rates and Death-Rates.

[2] It is necessary to recall that only one out of about every fourth child is a first-born. This would suggest that the effect of seasonal variation in marriage upon the seasonality in the birth-rate is slight.

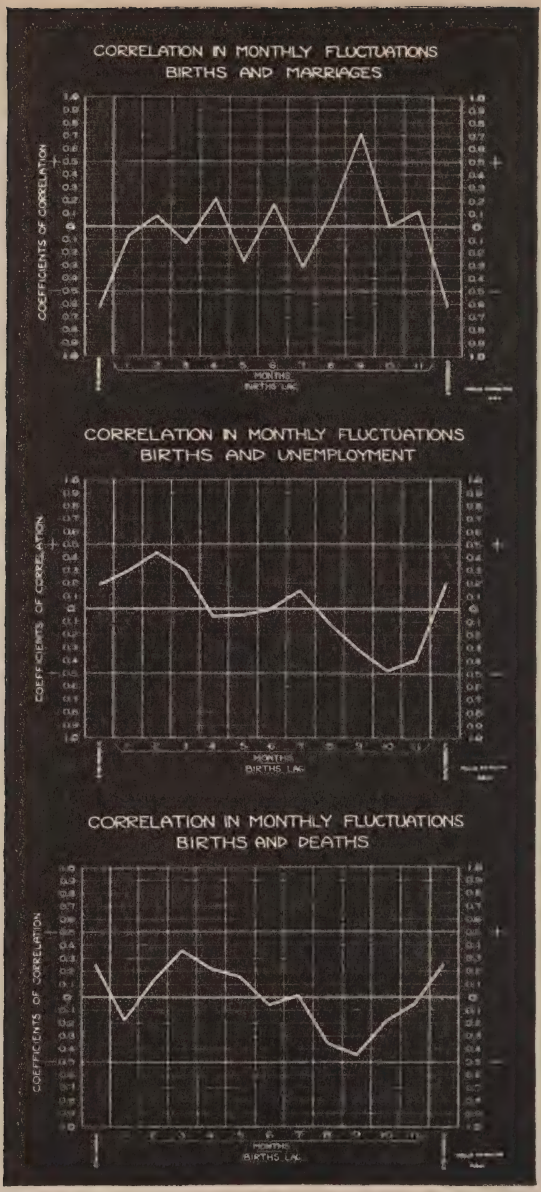
CORRELATION IN MONTHLY FLUCTUATIONS
BIRTHS AND MARRIAGES
COEFFICIENTS OF CORRELATION
MONTHS
CORRELATION IN MONTHLY FLUCTUATIONS
BIRTHS AND UNEMPLOYMENT
COEFFICIENTS OF CORRELATION
MONTHS
CORRELATION IN MONTHLY FLUCTUATIONS
BIRTHS AND DEATHS
COEFFICIENTS OF CORRELATION
MONTHS

CHART 24a

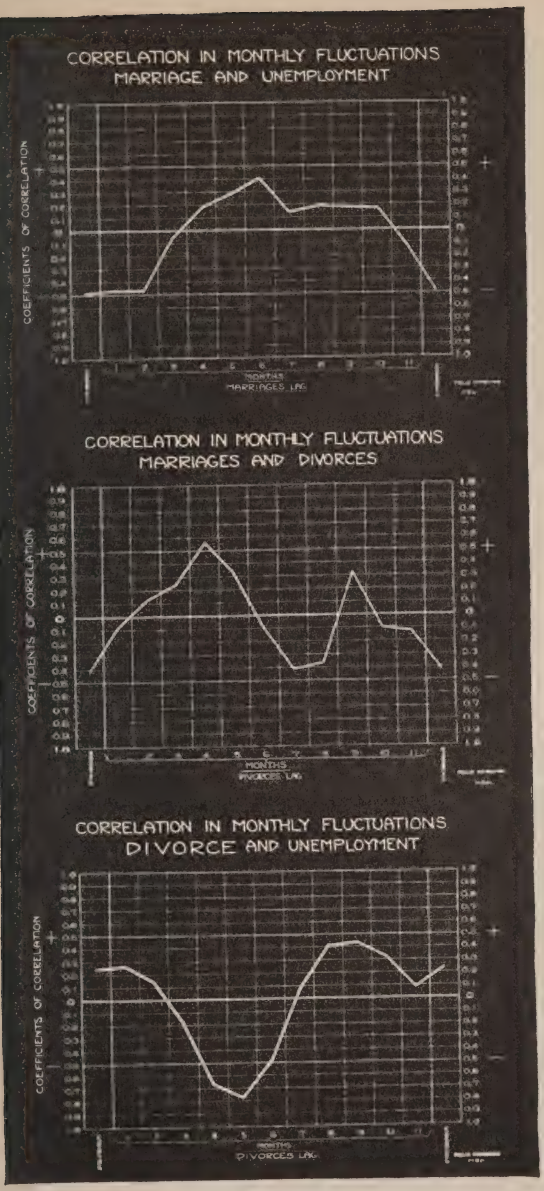
CORRELATION IN MONTHLY FLUCTUATIONS
MARRIAGE AND UNEMPLOYMENT
COEFFICIENTS OF CORRELATION
MONTHS
MARRIAGES LAG
CORRELATION IN MONTHLY FLUCTUATIONS
MARRIAGES AND DIVORCES
COEFFICIENTS OF CORRELATION
MONTHS
DIVORCES LAG
CORRELATION IN MONTHLY FLUCTUATIONS
DIVORCE AND UNEMPLOYMENT
COEFFICIENTS OF CORRELATION
MONTHS
DIVORCES LAG

CHART 24b

TABLE 52. SUMMARY TABLE, COEFFICIENTS OF CORRELATION IN SEASONAL FLUCTUATIONS

TIME RELATIONSHIP OF THE VARIATES[a]	BIRTH[a] AND MARRIAGE	BIRTH[a] AND UNEMPLOYMENT	BIRTH[a] AND DEATH	MARRIAGE[a] AND UNEMPLOYMENT	MARRIAGE AND DIVORCE[a]	DIVORCE[a] AND UNEMPLOYMENT
Synchronous	−.6281	+.1967	+.2475	−.4824	−.4134	+.2466
Lag 1 month	−.0661	+.3016	−.1752	−.4679	−.0833	+.2707
Lag 2 months	+.0882	+.4408	+.1321	−.4638	+.1242	+.1526
Lag 3 months	−.1158	+.3069	+.3634	−.0564	+.2451	−.1655
Lag 4 months	+.2020	−.0545	+.2237	+.1871	+.5619	−.6610
Lag 5 months	−.2713	−.0429	+.1644	+.2886	+.3331	−.7692
Lag 6 months	+.1629	±.0000	−.0482	+.4135	−.0928	−.4856
Lag 7 months	−.3148	+.1479	+.0192	+.1466	−.4089	+.0914
Lag 8 months	+.1305	−.1082	−.3496	+.1959	−.3628	+.4136
Lag 9 months	+.7109	−.3121	−.4416	+.1791	+.3225	+.4396
Lag 10 months	−.0096	−.4749	−.1967	+.1705	−.1003	+.3228
Lag 11 months	+.1157	−.3989	−.0536	−.1107	−.1253	+.0961
Synchronous	−.6281	+.1967	+.2475	−.4824	−.4134	+.2466

[a] Represents the variate which is "lagging."

There is also a strong likelihood, from the data submitted, that there is a powerful seasonal variation in the sex impulse. When we correlated the seasonal indexes of the birth-rate and the death-rate, we found that the maximum coefficient was secured when the birth-rate lagged nine months behind the death-rate, or, in other words, when we paired deaths and conceptions. In this case the coefficient was rather high and *inverse*. This suggested the inference that the forces which affect the seasonal variations in births and deaths act upon them in opposite directions.

When we paired the seasonal fluctuations in marriages with the seasonal variations in unemployment, we found that the highest coefficient was secured by comparing the variations without any lag whatsoever; in other words, when we compared January with January, and, say, October with October. In that case the coefficient is high and inverse. This suggested the thought that, so far as the seasonal variations in the number of marriages is concerned, more marriages are performed when there is more work: in other words, the smaller the seasonal unemployment, the larger the number of marriages.

Correlating the seasonal indexes of the number of divorce libels filed produced some interesting descriptions. We found that correlating the seasonal variation of the divorce phenomenon with seasonal unemployment produced a very high coefficient of correlation when we paired the two occurrences so that the divorce curve lagged five months behind the unemployment curve. In this case the coefficient was negative. This suggests the interpretation that when seasonal *unemployment* is *heavy*, five months later the seasonal variation in *divorces* is *low*. When we analyzed the relation between the seasonal variation in marriages and the seasonal fluctuation in divorces,

we found that the maximum coefficient was secured when divorces lagged four months behind seasonal variations in marriages. In this case, however, the coefficient is positive. This suggests that the influences which cause the seasonal variations in both these human experiences act in a similar manner upon both of them; it may further well be that there is suggested a closer relationship between the two, inasmuch as the month in which a marriage is completed bears a direct relation, after a lapse of time, to the month in which a divorce libel *may* be filed. In addition, we suggested that a study of the seasonal variations in these two situations, together with seasonality in unemployment, by the method of partial correlation indicated, in still more uncertain terms, that seasonality in divorce fluctuates in opposite direction from seasonal variations in unemployment.[1] We conclude that bad times do not occasion a rise in divorces.

C. Cyclical Fluctuations

We noted that there were definite cycles in these human occurrences. We saw that there are these well-marked periods in which the data exhibit that "ebb and flow" which characterizes cycles in economic statistics.[2] We have drawn all of these Twelve-Months Moving Average of Cycle Figures on one chart. The fluctuations in each one of these series can be directly compared, since the items are in terms of the Standard Deviation of each

[1] The following are the Standard Deviations of the Seasonal Indexes:

Birth-rate	2.2874	Marriages	40.1360
Death-rate	7.666	Divorce-rate	18.8409

[2] "The ebb and flow of business by a process of gradual change constitutes the business cycle." Warren M. Persons, *Indices of General Business Conditions*, with a Prefatory Statement by Charles J. Bullock (Cambridge, 1919), p. 33.

series, and the scale used throughout is uniform. This constitutes Chart 25.[1] It will be noted from this summary chart that cycles in demography exist.[2] Let us turn, very briefly, to a comparison of certain phases of these curves.

Notice the curves for the birth-rate and the death-rate. Both, starting above the line in 1900, swing downward (the drop in the birth-rate preceding the drop in the death-rate), and, after a lapse of some years, flow upward so that about the middle of the year 1908 these two phenomena have completed the cycle. We must note, however, that the upward swing in the death-curve precedes the rise in the birth-curve; once begun, however, the flow

[1] The actual data for this chart will be found in Tables 8, 18, 28, 38, and 48.

[2] The following is a suggested interpretation of demographic cycles by Schnapper Arndt (*op. cit.*, p. 118):

"Eine schöne Betrachtung, die man an die Untersuchungen über den Altersaufbau geknüpft hat, betrifft die sogen, demographischen Zyklen, die freilich mehr in das Kapitel von der Bewegung der Bevölkerung gehört. Wir sagten, dass eine der Ursachen, die für die Eigentümlichkeiten eines Altersaufbaues bestimmend seien, in der Verschiedenartigkeit der Geburtenhaufigkeit liege. Wenn wir etwa im Laufe des Jahres 1902 viel weniger Geburten haben sollten als im Jahre 1901, so werden die Geborenen des Jahres 1902, die in den Jahren 1932/33 ihr 30–31. Altersjahr verleben werden, in diesen Jahren weniger zahlreich sein, als es die Generation von 1901 in den Jahren 1931/32 war. Wenn aber das der Fall ist, so wird die Generation von 1902 in ihrem 30–31. Altersjahr auch wiederum weniger Kinder erzeugen als die Generation von 1901 in dem entsprechenden Altersjahr, ganz einfach, weil sie — wie gesagtan Zahl schwacher ist.

"Wenn wir nun aber auf diese Weise in den Jahren 1932 bis 1934 weniger Geburten erhalten, so werden eben die dann Geborenen ihrerseits wieder weniger 30–31 in die Jahre 1962 bis 1965 hineinwachsen lassen als eine frühere Generation. Und so muss sich das Manko in einer Jahresgeneration — mehr noch das aus mehreren aufeinander folgenden, also ein etwaiges Manko in den Generationen 1902, 3, 4 gegenuber 1899, 1900, 1901 — nicht nur in der Anzahl jeder Altersklasse geltend machen, die sich auf diese Generation zurückführen lasst, sondern auch in der besetzung jeder Altersklasse, die von den Nachkommen jener Generation abstammt. . . . Demographische Zyklen! Die Spuren von Kriegen können sich auf diese Weise noch lange bemärkbar machen. . . . Die Folge der Unglücksfalle, die während der Zeit von 1795–1810 über Schweden hereinbrachen, hat man in den Eigentümlichkeiten des Altersaufbaues noch lange hinaus erkennen können."

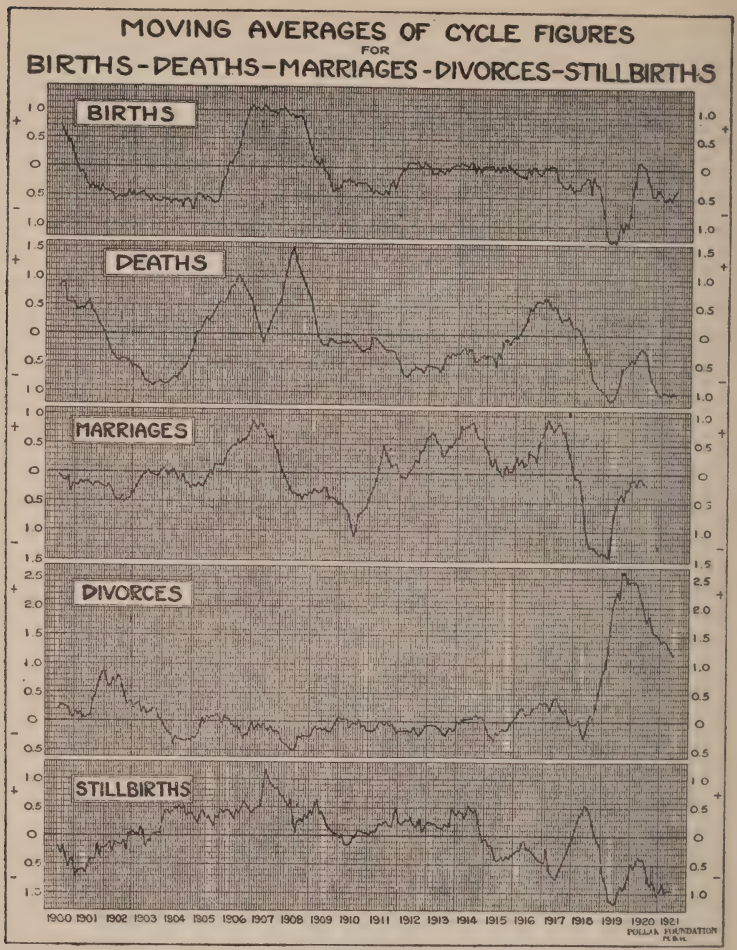

CHART 25

in the birth-curve is more rapid and sustained. There is the drop in the death-curve for the year 1907. The curves for both these human experiences are below the line for portions of the years 1909, 1910, and 1911. Thenceforward, for about five years, the curve for births hovers

very closely about the line, during which time the death-curve is consistently below the line to a marked degree. The death-curve flows above the line early in 1916 and continues upward for the entire year. At the beginning of the following year a decline begins. Four months later the decline in the birth-curve commences to ebb. The birth-curve had been so close to the line for so many years that a very small ebb took it below the line; the death-curve having been above the line, the years 1916 and 1917 did not get across the line until the spring of 1918. It is to be noted, however, that the ebb of the death-curve preceded the drop of the birth-curve. Note, too, that the trough formed by the death-curve is much wider than the one depicted by the birth-curve. Note, likewise, that the upward flow of the death-curve in the year 1919 precedes the lift of the birth-curve. The curve for births, however, rises sufficiently to cross the line; the death-curve rises during the year 1919 and for part of 1920, but begins to ebb before it reaches the line.[1]

Turn for a moment to a comparison of the curves representing marriages and the birth-rate. The marriage-curve is below the line for the years 1901, 1902, and for part of 1903, during which time the birth-curve is also at its ebb phase. The latter curve, however, remains below the line for the additional years of 1903, 1904, and 1905; but the marriage-curve rises in the spring of 1903 to touch the line, and, remaining in that vicinity for about a year, dips below the line for about nine months — from about June, 1904, through September, 1905. The rise in the marriage-curve continues until it reaches its maximum in January, 1907. This rise in the marriage-curve precedes the rise in the birth-curve, the latter crossing the line

[1] We summarize below the course of all of these curves during the War period.

early in 1906, continuing on upward at a more rapid rate than the marriage-curve until it reaches its maximum late in 1906, where it remains, almost stationary, for about fifteen months. The marriage-curve begins to decline early in 1907, and continues downward throughout the whole year, crossing the line early in 1908. The decline in the birth-curve begins about fifteen months after the decline in the marriage-curve began — that is, in the spring of 1908 — and continues to fall more rapidly than the marriage-curve, crossing the line in May, 1909. The marriage-curve and the birth-curve are below the line for almost three years: — marriages in the years 1908, 1909, 1910; births during 1909, 1910, and 1911. Thenceforward, the relationship is not so plain. The marriage-curve is noticeable above the line in 1911, and for the latter half of 1912, and then for the two years 1913 and 1914. Another up-swing is shown in 1916 and 1917. From 1912 through the first half-year of 1917, the birth-curve hovers very closely around the line — the fluctuations being too small to be appreciable. The marriage-curve shows a sharp decline in 1917 to the lowest point it reaches during the twenty-one years under survey, in the spring of 1919. Again, fifteen months after the pronounced decline begins in the marriage-curve, to which we just alluded, the birth-curve begins a marked decline — that is, in October, 1918. The marriage-curve begins to move upward in March, 1919. Several months later the birth-curve likewise begins to flow upward — the latter crossing the line, the former never reaching it in this cycle.

It will be profitable to look especially at the fluctuations in these essentially human experiences which occurred during War times. A short study of Chart 25 will make certain sequences clear. Marriages and deaths seem to decline almost simultaneously; even the minor fluctua-

tions are rather similar. The decline in the birth-rate occurs about eleven months after the fluctuations in the marriage-curve. Part of this decided decline is due to the influenza epidemic. Nevertheless, the various convolutions of the two curves are very similar. War indubitably decreases the birth-rate[1] and the number of marriages.[2] The cessation of hostilities quickly sees the return to the normal or even above the normal with respect to these vital phenomena. War seems to have increased very noticeably the number of divorce cases. We noted earlier that this increase could be due neither to economic circumstances, nor to War marriages. We are urged to the conclusion that the increase is in all probability due to post-War psychology — uncertainty, lack of belief in established values, uprooted individuals and thoughts — a short taste of freedom and independence. All of these circumstances are new to, or are found in increased volume or intensity during, this post-War situation. The conformation of the curve seems to suggest that the increase in divorces is not a permanent feature.

There are certain additional features suggested by these analyses to which it is advisable to allude before we begin a discussion of Part Two of this monograph. The analysis

[1]

Year	Birth-Rate	Marriage-Rate
1860	29.28	20.15
1861	28.63	17.72
1862	25.92	17.68
1863	24.20	17.36
1864	24.17	19.87
1865	23.87	20.60
1866	26.16	22.15
1867	26.17	

(*Vital Statistics of Massachusetts, 1856–95*, Pub. Doc. No. 34, p. 736.)

[2] This has also been demonstrated for France during the Franco-Prussian War. W. Ogle, "On Marriage Rates and Marriage Age with Special Reference to the Growth of Population," *Journal of the Royal Statistical Society*, vol. LIII (June, 1890), pp. 225–56.

of all of these series[1] reflecting happenings in the daily life of men, which run over a number of years, suggests that simple comparisons of one month with another month are liable to err greatly. We frequently are met with the statement that the death-rate for a certain month of a certain year is lower than the death-rate for the same month in a different year. Now this difference may merely reflect a difference arising out of the phase of the demographic cycle. These crude comparisons are frequently used by public health officials to indicate concrete achievements. While a lower death-rate may be the direct result of a health crusade, the simple comparisons suggested as a rule do not demonstrate such a causal connection. Before comparisons can be made in these series they must be subjected to the same analysis which economists now apply to their studies. The study definitely shows that these series reflecting the social and biological side of mankind can (and must) be analyzed ere descriptions of happenings are ventured and causal relationships postulated.

Note well that the trends in the birth-rate, death-rate, and stillbirth-rate are all negatively inclined. The trends for divorces and marriages are upward. In all historical or time series which reflect the condition of economic society in any particular dimension there is present this developmental factor. Society rarely presents a static condition — there is either growth or decline. It follows, then, that if the historical series with which we are concerned truly reflects the society from which it is gathered, this developmental feature will appear. This growth or decline element depends, for example, on the varying sizes

[1] In reality, these series might be called bio-statistical time series, or historical-sociological series. Such a classification might tend to further analysis of these occurrences.

of the population at various years; it likewise depends upon the gradual expansion of industry. It is most important that the trend be eliminated before comparisons are made with other time series. Otherwise we shall not get out "of the morass which Sir Arthur Newsholme, Mortara, and other statisticians had got us into, by correlating time growths of various factors."[1] From correlating time series one with the other, without first removing the trend from each, a spurious relationship results. All that the result under such conditions indicates is the degree to which these series reflect similar influences of trend. And that tells us less than nothing — it is misleading information. If the trends are similar — both either up or down — we secure a high positive correlation; if the trends are diverse — one up and the other down — we secure a high inverse correlation. "Now we know that if we correlate the falling phthisis death-rate with the falling birth-rate, we shall have a correlation of the order 0.9. But no one is likely to believe there is an *organic* relationship between the two of this order — any more than one believes that the correlation between the cancer death-rate and the increasing expenditure on apples per head of the population, the value of which is 0.89, is a true organic relationship, that is, is due to one or more common factors in the two variates. Such high correlations as arise from common growth or decline with time, when interpreted as causal or semi-causal relationships, are, in our opinion, perfectly idle, indeed are only too apt to be mischievous, and we shall reach nothing, or less than nothing — knighthoods — by the investigation of them."[2]

[1] Pearson and Elderton, "On the Variate Difference Method," *Biometrika*, vol. XIV (March, 1923), p. 290.

[2] Pearson and Elderton, *loc. cit.*, pp. 282–83. See also Karl Pearson, *Social Problems, Their Treatment, Past, Present, and Future* (London, 1912), pp. 31–32.

It is plain, in addition, that much is likely to be gained by breaking up these time series reflecting these human happenings into their component parts. We have shown that it is possible to isolate the seasonal fluctuation after the influences of the trend have been removed. We have shown, also, that it is possible to separate the "ebb and flow" in the birth-rate, death-rate, stillbirth-rate, in marriages and divorces. After such an analysis it is possible to describe, in much simpler terms and with a firmer assurance of accuracy, fluctuations in these occurrences.

PART TWO

CHAPTER VIII

CYCLICAL CORRELATIONS

We have thus far succeeded in demonstrating that series of demographic data can be broken up into simpler series. We have shown that crude series reflecting the condition of humankind — such as the birth-rate, death-rate, marriage, and divorce — are the result of four distinct forces which it is possible to isolate. It is clear that it is possible to break up these large mysteries into smaller ones; and that it is possible to explain these simpler mysteries more clearly than is possible for the larger ones.[1] In order to understand the relationship between these phenomena happening to men, we must remove certain influences before comparisons can be made. If we compare, for example, the fluctuations of the birth-rate with the fluc-

[1] The following is quoted from the inspiring introduction to *Mind and Heredity*, by Vernon Kellogg (Princeton, 1923), pp. i–iii: "We have a convenient single word to express our confession of ignorance when faced with things we do not understand. We apply this word to the unexplained things of our own body, to things in the world about us, to things of the apparently infinite universe. We call such things mysteries, and to many of us, especially the more tender-minded among us, the labeling of a thing as mystery ends discussion of it. To others, tougher-minded, it is the very incitement to discussion, and, to some, the activating stimulus to prolonged and feverish study. It is, of course, chiefly, if not entirely, by such study that we ever can and do get anywhere in the fascinating game of solving mystery.

"The methods of such study are familiar; they are primarily descriptive and analytic. We call them scientific. They break up the big mystery into little ones; they sometimes succeed in reaching an immediate — although never an ultimate — rather satisfying explanation of some of these little parts of the big whole. By these methods we re-describe, which is a form of approximate explanation, these parts of the mystery and sometimes the whole mystery. If it is a mystery of life and so-called vital forces — and no kind of mystery is more fascinating to us nor more feverishly discussed and studied than this kind — we re-describe it, or bits of it, in terms of non-life, and of forces of physics and chemistry."

tuations in marriages, it must be clear that the influences of trend must be removed; otherwise the strong trends in each one of these series will result in giving an inverse relationship which may or may not be true for other forces which act simultaneously upon these respective occurrences.[1] We have further studied the relationship existing between the seasonal indexes of these series and certain series reflecting society at large; we have also presented some studies of the relationship between the seasonal fluctuations of these series among themselves. We turn now to a study of the relationship between the cyclical fluctuations of these human happenings and the cyclical fluctuations of certain series which indicate the variations in the economic aspect of society.[2] We present the following eight comparisons:

1. Correlation between the birth-rate and wholesale prices.[3]
2. Correlation between the birth-rate and employment [4] in Massachusetts.

[1] In statistical categories, what we have shown is that these *crude* series do not meet the test of homogeneity. See Franz Žižek, *Statistical Averages* (New York, 1913), pp. 65–80.

[2] In this connection note that the Cycle Figures are in the form of deviations from the mean, divided by the Standard Deviation. Now the Pearsonian coefficient is written

$$r = \frac{\Sigma xy}{N\sigma_x\sigma_y}.$$

All that we need do is to cross-multiply and then divide by the number of paired items and we have the coefficient of correlation. An interesting suggestion concerning this statistical constant has been made by Armand Julin (*Principes de Statistique, Théorique et Appliquée* (Bruxelles, 1921), p. 479), who proposes the name "covariation," since that term does not carry the connotation of causality which the term "correlation" has come to imply.

[3] We refer to the United States Bureau of Labor, *Monthly Index Numbers of Wholesale Prices of All Commodities*. The Cycle Figures are found in Persons, *op. cit.*, pp. 191–97. We did not go beyond 1916 because the War has churned up the data so that it is still impossible to tread one's way with any degree of accuracy.

[4] Kindly supplied me by Professor William A. Berridge, of Brown University.

3. Correlation between the birth-rate and the death-rate.
4. Correlation between the stillbirth-rate and wholesale prices.
5. Correlation between the death-rate and wholesale prices.
6. Correlation between the death-rate and employment in Massachusetts.
7. Correlation between marriages and wholesale prices.
8. Correlation between divorces filed and prices.

It is not to be supposed that cyclical fluctuations in wholesale prices or in employment tell the whole story of the fluctuations in economic well-being, although "employment yields a highly satisfactory index of industrial cycles both before and since the War." [1] It is suggested, however, that these two features of industrial society come closest to the average man. The man in the street is not cognizant of industrial cycles in pig-iron production or in fluctuations in the "Rate on Four- to Six-Months Paper." The average man, however, is aware of cyclical variations in employment and prices. It is discussed in the papers and at the dinner table; it is a topic at club meetings and political rallies; he knows when production is slackening and when his comrades are being "laid off." These variations impinge upon his consciousness daily.

As a rule [2] we have worked out the correlations for three periods: the first ending with December, 1908; the second ending with December, 1911; the third ending with December, 1916. These three periods were suggested by a

[1] Berridge, *op. cit.*, p. 67.

[2] In the case of correlating the birth-rate with the death-rate, the third period ends with December, 1919. Furthermore, the third period is omitted in the case of the death-rate and employment in Massachusetts.

careful reference to Chart 25 and by the strictures placed upon the two correlative series (prices and employment) by the War.

We have, furthermore, worked out the coefficients of correlations for varying periods of lag and lead.[1] As a rule we have presented these coefficients of correlation for twenty-five months' lag and twenty-five months' lead. It has been suggested that "experience has shown that correlation coefficients signify approximately the following degrees of correspondence between two economic time-series:

Below 0.50, very low.
From 0.50 to 0.60, rather low.
From 0.60 to 0.70, fair.
From 0.70 to 0.80, good.
From 0.80 to 0.90, very good.
Over 0.90, excellent."[2]

[1] It will be well to explain just what is meant by "lag" and "lead" in correlating time-series. If A goes east invariably at the same instant that B goes east, we shall have *perfect positive* correlation. If A goes west invariably at the same time that B goes east, we shall have *perfect inverse* or *negative* correlation. If A goes west invariably five minutes after B goes west, we secure *perfect positive* correlation with A *lagging* five minutes (or, what is the same thing, with B *leading* five minutes). If A goes east invariably five minutes after B goes west, we secure *perfect negative* correlation, with A *lagging* five minutes. This degree of covariation is expressed by the coefficient of correlation varying between +1.00 and −1.00, passing through zero. It is plain that this relationship is not necessarily causal. Since everything that happens must occur in time, in correlating time-series particularly must the coefficients be interpreted with great caution, since from a certain point of view all time-series are correlated to some degree or other. In coefficients secured from time-series, moreover, we cannot control our results by an appeal to the statistical constant known as the "Probable Error." See the Presidential Address by Professor Warren M. Persons to the Eighty-Fifth Annual Meeting of the American Statistical Association. This is the first chapter in Number Six of the Pollak Publications, *The Problem of Business Forecasting.*

[2] Berridge, *op. cit.*, p. 24.

These conclusions have been drawn, however, empirically in economic research,[1] and are subject to revision.

[1] Note for example the following coefficients secured in the biological sphere, presented by Pearl (*op. cit.*, pp. 174–75):

PARENTAL INHERITANCE OF PHYSICAL CHARACTERS IN MAN (*Pearson*)

PAIR	ORGAN	CORRELATION
Father and son	Stature	.51
Father and son	Span	.45
Father and son	Forearm	.42
Father and son	Eye color	.55
Father and daughter	Stature	.51
Father and daughter	Span	.45
Father and daughter	Forearm	.42
Father and daughter	Eye color	.44
Mother and son	Stature	.49
Mother and son	Span	.46
Mother and son	Forearm	.41
Mother and son	Eye color	.48
Mother and daughter	Stature	.51
Mother and daughter	Span	.45
Mother and daughter	Forearm	.42
Mother and daughter	Eye color	.51

FRATERNAL INHERITANCE OF PHYSICAL CHARACTERS IN MAN (*Pearson*)

PAIR	ORGAN	CORRELATION
Brother and brother	Stature	.51
Brother and brother	Span	.55
Brother and brother	Forearm	.49
Brother and brother	Eye color	.52
Brother and brother	Cephalic index	.49
Brother and brother	Hair color	.59
Sister and sister	Stature	.54
Sister and sister	Span	.56
Sister and sister	Forearm	.51
Sister and sister	Eye color	.45
Sister and sister	Cephalic index	.54
Sister and sister	Hair color	.56
Brother and sister	Stature	.55
Brother and sister	Span	.53
Brother and sister	Forearm	.44
Brother and sister	Eye color	.46
Brother and sister	Cephalic index	.43
Brother and sister	Hair color	.56

See, also, *Modes of Research in Genetics*, Raymond Pearl, New York, 1915, pp. 42–72. We give the above degrees of correlation so that we can compare

1. The Correlation between the Birth-Rate and Wholesale Prices

"It is a curious fact," writes Yule, "that while the relations of the marriage-rate to economic factors have comparatively frequently drawn the attention of statistical writers, their effects on the birth-rate do not appear to have been nearly so fully discussed. Yet such a discussion must form the very basis of the theory of population in a modern industrial state."

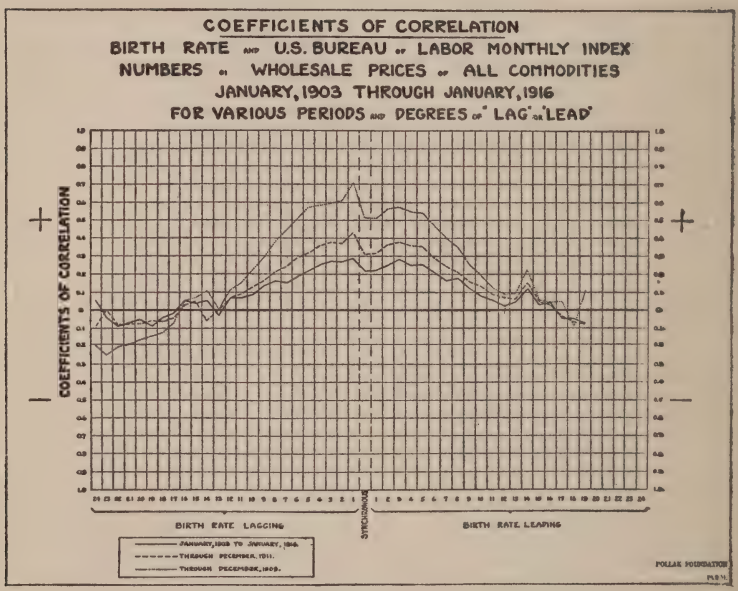
COEFFICIENTS OF CORRELATION
BIRTH RATE AND U.S. BUREAU OF LABOR MONTHLY INDEX NUMBERS OF WHOLESALE PRICES OF ALL COMMODITIES
JANUARY, 1903 THROUGH JANUARY, 1916
FOR VARIOUS PERIODS AND DEGREES OF "LAG" OR "LEAD"
COEFFICIENTS OF CORRELATION
BIRTH RATE LAGGING
SYNCHRONOUS
BIRTH RATE LEADING
THROUGH DECEMBER, 1911.
THROUGH DECEMBER, 1909.

CHART 26

Table 53 gives the coefficients of correlation between the birth-rate and wholesale prices for various periods and the coefficients derived in the present study. In the final analysis, however, we must fall back upon inter-comparisons. We can answer the questions: Do we secure a greater coefficient when the birth-rate lags or when it leads? — or, Is the correlation between prices and divorces as strong as the correlation between marriages and prices?

TABLE 53. COEFFICIENTS OF CORRELATION BETWEEN BIRTH-RATE AND WHOLESALE PRICES

TIME-RELATION	THROUGH DECEMBER, 1908	THROUGH DECEMBER, 1911	THROUGH JANUARY, 1916
Birth-rate lag 24 months	−.204	−.088	+.059
Birth-rate lag 23 months	−.259	±.000	−.039
Birth-rate lag 22 months	−.217	−.077	−.091
Birth-rate lag 21 months	−.199	−.075	−.067
Birth-rate lag 20 months	−.170	−.074	−.052
Birth-rate lag 19 months	−.152	−.057	−.084
Birth-rate lag 18 months	−.130	−.065	−.038
Birth-rate lag 17 months	−.066	−.039	−.015
Birth-rate lag 16 months	+.048	+.028	+.048
Birth-rate lag 15 months	+.065	+.044	+.032
Birth-rate lag 14 months	+.108	−.056	+.049
Birth-rate lag 13 months	000	±.000	+.028
Birth-rate lag 12 months	+.116	+.065	+.066
Birth-rate lag 11 months	+.151	+.091	+.066
Birth-rate lag 10 months	+.230	+.132	+.080
Birth-rate lag 9 months	+.288	+.160	+.135
Birth-rate lag 8 months	+.377	+.208	+.158
Birth-rate lag 7 months	+.442	+.241	+.150
Birth-rate lag 6 months	+.506	+.288	+.184
Birth-rate lag 5 months	+.565	+.320	+.215
Birth-rate lag 4 months	+.583	+.359	+.249
Birth-rate lag 3 months	+.597	+.377	+.271
Birth-rate lag 2 months	+.611	+.366	+.264
Birth-rate lag 1 month	+.705	+.433	+.284
Synchronous	+.516	+.311	+.213
Birth-rate lead 1 month	+.510	+.315	+.219
Birth-rate lead 2 months	+.567	+.367	+.244
Birth-rate lead 3 months	+.577	+.381	+.280
Birth-rate lead 4 months	+.550	+.359	+.244
Birth-rate lead 5 months	+.539	+.349	+.246
Birth-rate lead 6 months	+.464	+.289	+.207
Birth-rate lead 7 months	+.399	+.241	+.162
Birth-rate lead 8 months	+.343	+.212	+.173
Birth-rate lead 9 months	+.250	+.160	+.122
Birth-rate lead 10 months	+.196	+.133	+.076
Birth-rate lead 11 months	+.128	+.091	+.052
Birth-rate lead 12 months	+.097	+.065	+.021
Birth-rate lead 13 months	+.096	+.055	+.039
Birth-rate lead 14 months	+.225	+.149	+.120
Birth-rate lead 15 months	+.052	+.041	+.031
Birth-rate lead 16 months	+.038	+.028	+.038
Birth-rate lead 17 months	+.050	−.040	−.044
Birth-rate lead 18 months	−.095	−.064	−.044
Birth-rate lead 19 months	+.112	−.078	−.072

degrees of lag or lead. These coefficients appear in Chart 26. There are two striking features about the Chart. The first is the smoothness and regularity with which the coefficients rise from around the zero correlation line to the maximum, and then decline with similar regularity. The second feature is the consistent results for the sub-periods.[1]

It will be noted that the coefficient reaches its maximum when the birth-rate lags one month behind the cyclical fluctuations in wholesale prices. In that case the co-

[1] "The recognition of this belief in a general orderliness of affairs is necessary if we are to understand the manner in which the statistician moulds his investigation and arrives at a statistical inference. In the first place, he follows, as well as his material allows, the method of the experimental scientist when he selects, as a basis for forecasting, a past period for study as nearly as possible like that of the present. He attempts to find a specific analogy existing in an orderly universe. But he realizes that analogies differ greatly in their persuasive quality. The importance for an inference of a given statistical result pertaining to a given period is greatly increased, first, if similar or consistent statistical results obtain for sub-periods; second, if similar or consistent statistical results obtain for other periods and under different circumstances; and third, if all of the statistical results agree with, are supported by, or can be set in the framework of, related knowledge of a statistical or non-statistical nature. To illustrate the first point, if we have found, for instance, that a periodic function with a period of forty months fits a time series of money rates for a span of fifty years, the conclusion that there is a real period of forty months for the entire span is strengthened if we obtain the same periodic function for each of two or more segments of the given fifty years. Also, to illustrate the second point, the conclusion is further strengthened if the same function is found for other than the given fifty-year span and its segments. Likewise, the conclusion of a forty-months period would be further supported by the securing of evidence, statistical or otherwise, of corresponding fluctuations in business affairs. In other words, stability of statistical results and agreement with non-statistical results are potent arguments for continued stability in an orderly universe." (Persons, *loc. cit.*, pp. 5–6.)

It will be noted that Professor Persons here erects three criteria for the inductive argument of the statistician. The consistence of the sub-periods is shown in each separate study in correlation of the Cycle Figures. This is Professor Persons's first test. His second test turns on similar or consistent statistical findings in other studies; to these data we allude in the main discussion. His third test we apply in the concluding chapter, where a suggestion is offered for a possible explanation of certain features of business cycles which turns on the psychological approach.

efficient reaches the very high position of +.705. It is to be noted, however, that we are dealing with wholesale prices.[1] Retail prices lag behind wholesale prices several months. In addition, it will be recalled, we deal with births. If we change to *conceptions* (as we did in correlating the seasonal fluctuations), we find that the maximum correlation between conceptions and prices is secured when *conceptions lead* by about eleven months.

2. Correlation between Birth-Rate and Employment

Let us turn for a moment to another side of the struggle for existence, which is very close to the mass of humanity. We have employment in mind. It requires no great stretch of imagination to believe that the fluctuations[2] in prices together with fluctuations in employment are powerful influences in the habits and mental attitudes of the working people. With this thought in mind, we present Table 54, which shows the coefficients of correlation reached when studying the relationship between the birth-rates and cyclical employment. Graphically, these coefficients are presented in Chart 27. Notice the same general consistence of the sub-periods to which we alluded in discussing the correlations between the birth-rate and wholesale prices. Notice also that the coefficients rise on both sides of the concurrent period to their maximum and then recede. In this case, however, the coefficients are practically all positive when the birth-rate is lagging; conversely, they are all negative when the birth-rate is leading. It will be apparent, however, that the maximum correlation is reached when the birth-rate *leads*

[1] The time-relationship between wholesale prices and certain other correlative series is presented by Professor Persons, *op. cit.*, pp. 186–87.

[2] We have in mind, at this point, cyclical fluctuations. Seasonal variations have been dealt with earlier.

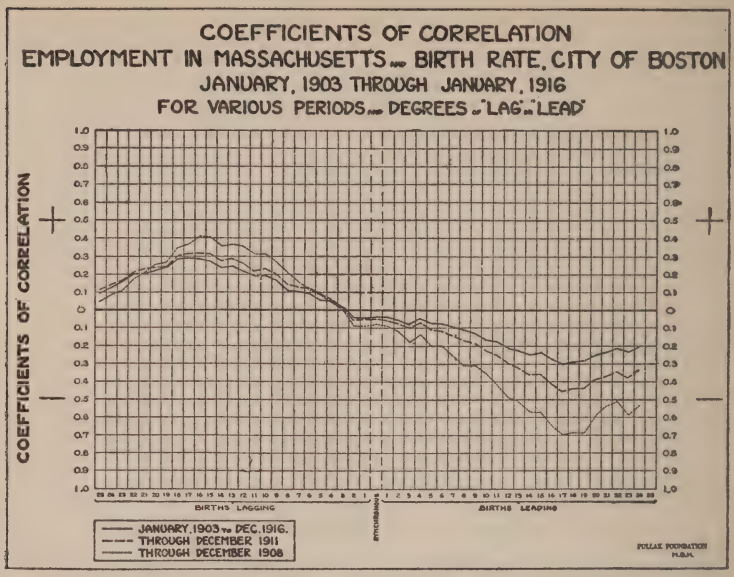

CHART 27

the cyclical fluctuations in employment seventeen months, when the high coefficient of −0.696 is reached for one subseries. This suggests the statement that, seventeen months after positive fluctuations in the birth-rate, the cyclical fluctuation of employment is in the negative direction and conversely.

We note, then, that the birth-rate varies directly with wholesale prices and with unemployment. Also that the maximum coefficients of correlation are reached when the birth-rate leads. We noticed, likewise, the general consistence of subdivisions of the whole series, a fact which added weight to the statistical inferences. We recall, in this connection, the fact that when we correlated the seasonal indexes in the birth-rate with seasonality in unemployment we found a coefficient of −0.4749 when the birth-rate lagged ten months. The coefficient was

TABLE 54. COEFFICIENTS OF CORRELATION BETWEEN BIRTH-RATE AND EMPLOYMENT

TIME-RELATION	THROUGH DECEMBER, 1908	THROUGH DECEMBER, 1911	THROUGH JANUARY, 1916
Birth-rate lag 25 months	+.046	+.113	+.094
Birth-rate lag 24 months	+.084	+.144	+.128
Birth-rate lag 23 months	+.110	+.163	+.159
Birth-rate lag 22 months	+.174	+.214	+.203
Birth-rate lag 21 months	+.209	+.232	+.207
Birth-rate lag 20 months	+.254	+.241	+.226
Birth-rate lag 19 months	+.270	+.248	+.244
Birth-rate lag 18 months	+.349	+.308	+.283
Birth-rate lag 17 months	+.370	+.317	+.292
Birth-rate lag 16 months	+.410	+.322	+.285
Birth-rate lag 15 months	+.405	+.313	+.272
Birth-rate lag 14 months	+.358	+.274	+.237
Birth-rate lag 13 months	+.368	+.287	+.247
Birth-rate lag 12 months	+.356	+.261	+.220
Birth-rate lag 11 months	+.314	+.221	+.190
Birth-rate lag 10 months	+.315	+.234	+.195
Birth-rate lag 9 months	+.271	+.202	+.168
Birth-rate lag 8 months	+.210	+.147	+.113
Birth-rate lag 7 months	+.160	+.128	+.103
Birth-rate lag 6 months	+.113	+.123	+.095
Birth-rate lag 5 months	+.084	+.085	+.060
Birth-rate lag 4 months	+.047	+.063	+.052
Birth-rate lag 3 months	−.002	+.008	+.011
Birth-rate lag 2 months	−.086	−.057	−.043
Birth-rate lag 1 month	−.090	−.056	−.043
Synchronous	−.078	−.051	−.037
Birth-rate lead 1 month	−.091	−.057	−.043
Birth-rate lead 2 months	−.120	−.074	−.056
Birth-rate lead 3 months	−.172	−.102	−.074
Birth-rate lead 4 months	−.137	−.070	−.046
Birth-rate lead 5 months	−.200	−.109	−.072
Birth-rate lead 6 months	−.197	−.118	−.075
Birth-rate lead 7 months	−.253	−.146	−.094
Birth-rate lead 8 months	−.306	−.167	−.111
Birth-rate lead 9 months	−.308	−.186	−.130
Birth-rate lead 10 months	−.352	−.225	−.165
Birth-rate lead 11 months	−.415	−.249	−.176
Birth-rate lead 12 months	−.485	−.296	−.209
Birth-rate lead 13 months	−.507	−.321	−.223
Birth-rate lead 14 months	−.570	−.357	−.244
Birth-rate lead 15 months	−.571	−.354	−.233
Birth-rate lead 16 months	−.644	−.407	−.272
Birth-rate lead 17 months	−.696	−.449	−.302
Birth-rate lead 18 months	−.680	−.437	−.284
Birth-rate lead 19 months	−.686	−.435	−.278
Birth-rate lead 20 months	−.593	−.387	−.246
Birth-rate lead 21 months	−.537	−.367	−.231
Birth-rate lead 22 months	−.508	−.340	−.212
Birth-rate lead 23 months	−.583	−.375	−.232
Birth-rate lead 24 months	−.530	−.331	−.205

positive (+0.4408) when the birth-rate lagged two months behind seasonal variations in unemployment.[1] We are therefore urged to the statement that the relationship between cyclical fluctuations in the birth-rate and cyclical fluctuations in employment is directly opposite from the relationship between the seasonal disturbances in the birth-rate and seasonal variations in employment. In the former case the relationship is inverse; in the latter case it is positive.[2]

It will be interesting to refer very briefly to the findings of other investigations. We take up first those which have utilized the correlational calculus. Professor Ogburn and Miss Thomas found [3] that for certain States for the period 1870–1920, a correlation with indexes of business of +.33 was reached when the birth-rate lagged one year. With a similar procedure, they reached for England and Wales for the period 1874–1910 a coefficient of +.15. From these data they conclude "that there is a light tendency for birth-rates to increase in prosperity after a year's lag and to decrease in depression." This may be due in part to the fact that marriages are so highly correlated with business conditions. We must note, in the first place, that in both these instances the coefficients are positive. We note, further, that in the study for certain States of the United States only fifty items were paired, namely, 1870–1920. In the study for England and Wales, only thirty-six items were used. In the present study, since the material is in monthly form, many more items

[1] For reasons explained above (see footnote 1, page 25), it is not possible to get such a delicate adjustment of lag and lead in correlating seasonal fluctuations. A lag of ten months may also be a lead of two months in these seasonal correlations.

[2] This is another instance of the gain to be achieved in sociological investigation through the isolation of the results of divergent forces.

[3] *Loc. cit.*, p. 339.

are involved.[1] We may well pause and marvel at the fact that by correlating these *monthly* fluctuations[2] we reach such a high coefficient.[3]

Let us turn for a few moments to certain other studies of the relationship between fluctuations in the birth-rate and economic conditions. Mayo-Smith has summarized some of the older evidence. "Von Mayr has shown by means of a diagram that during the twenty-five years from 1835–60 any violent rise in the price of rye in Bavaria, such as occurred in 1845 and again in 1853, was followed by a fall in the number of births. After 1860 the relation is obscured, and with a single interruption, births seem to go on utterly regardless of the price of food. There is a local explanation for this, inasmuch as the Bavarian marriage laws, which had been very severe, were relaxed in 1862 and entirely abolished in 1868. This encouraged marriage, and doubtless affected births. Even before 1860 the fluctuations in the price of food were much more violent than the corresponding fluctuations in the number

[1] If the statistical constant known as the Probable Error were applicable to coefficients of correlation secured from time series in the same manner in which it is used in attributive variables, we could express this difference in mathematical categories.

[2] It may be well that these monthly fluctuations are of a different kind from those noted in annual fluctuations. This offers a possible fruitful field of further study.

[3] G. U. Yule has studied the relationship between cyclical fluctuations in the birth-rate and cyclical fluctuations in the marriage-rate. He states that "in the first place there is the question, Does the short-period trade-cycle affect the birth-rate? It is obvious that some effect ought to be visible, for the trade-cycle produces oscillations in the marriage-rate, and these will give corresponding oscillations in the existing numbers of married women, and hence indirect, even if there be no *direct* effect, of trade on birth-rate." By a comparison of the calculated oscillations in the birth-rate due to oscillations in the marriage-rate with the actual oscillations in the birth-rate, Yule concludes that there are fluctuations in fertility. (G. U. Yule, "Changes in the Marriage- and Birth-Rates in England and Wales during the Past Half-Century," *Journal of the Royal Statistical Society* (March, 1906), pp. 122–25.)

of births, showing that the price of food was only one factor in the economic prosperity of the community. Since 1860, owing to the industrial and commercial development of Germany, the price of food has ceased to be the main factor in the economic life of the country."[1] Cauderlier[2] has the same thing in mind when he states that whenever economic conditions improve, the birth-rate increases. As we write, we find in the *New York Times* for February 7, 1924, the caption "Low Mark and Low Birth-Rate — Latter Decreased by Former, Medical Correspondent says."[3]

3. Correlation between Birth-Rate and Death-Rate

Table 55 shows the coefficients of correlation secured when comparing the cyclical fluctuations in the birth-rate with similar variations in the death-rates. These coefficients are graphically shown in Chart 28. The first feature of the Chart which stands out prominently by contrast with the two Charts just preceding is the lack of smoothness. The flow of the curves is first up, then down; then up and down again, and so on. The second feature to be noted is the fact that all of the coefficients are positive. We find the maximum correlation when the birth-rate

[1] R. Mayo-Smith, *Statistics and Sociology* (New York, 1896), pp. 74–75.

[2] G. Cauderlier, "La Loi qui règle les naissances," *Journal de la Société de Statistique de Paris* (January, 1902), pp. 11–27, and (February, 1902), pp. 44–62.

[3] "The decrease in the birth-rate of forty-six large German cities has been so rapid that, from April to June, only 65,925 living births, as compared with 69,631 in the preceding quarter and 75,726 in the second quarter of 1922, were recorded. Whereas in the second quarter of 1922 the birth-rate was 18.5, in the second quarter of 1923 it was only 15.8. Thus, the birth-rate for the large cities is almost as low as the minimal rates for the War years. Since, in the quarter during which the infants born in the second quarter of 1923 were conceived, namely, the third quarter of 1922, the catastrophal depreciation of the German mark had just begun, we must, in view of the close relationship between the exchange value of the mark and the birth-rate, be prepared to face further reduction of the birth-rate."

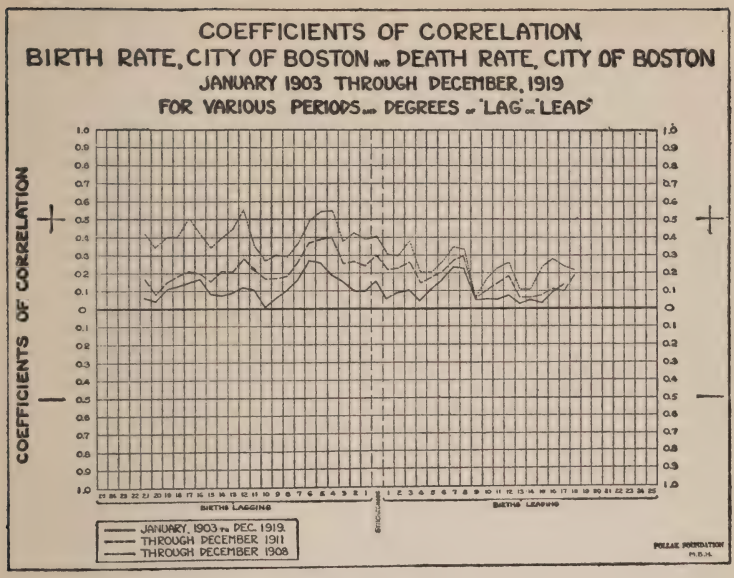
COEFFICIENTS OF CORRELATION
BIRTH RATE, CITY OF BOSTON AND DEATH RATE, CITY OF BOSTON
JANUARY 1903 THROUGH DECEMBER, 1919
FOR VARIOUS PERIODS — DEGREES OF "LAG" OR "LEAD"
COEFFICIENTS OF CORRELATION
BIRTHS LAGGING
SYNCHRONOUS
BIRTHS LEADING
JANUARY, 1903 TO DEC. 1919
THROUGH DECEMBER 1911
THROUGH DECEMBER 1908

CHART 28

lags exactly one year behind the death-rate. In that case the coefficient is +.553; the coefficient for birth-rate lagging four months is extremely close to this level, being +.550. It will be recalled that when we correlated the seasonal indexes of both these variates, we reached the maximum correlation when the birth-rate lagged nine months behind the death-rate. In that case, the coefficient was negative, −.4416. Professor Willcox [1] has

[1] *Loc. cit.*, p. 9. "As a rule, influences which tend to increase deaths tend to decrease births. This appears even in the rhythm of each day, Italian figures apparently showing that deaths are most frequent and births least frequent in the afternoon. There is also a yearly as well as a daily rhythm traceable in the figures, but in this case the reciprocal relationship is between conceptions as mirrored in the births nine months later and deaths. There is some evidence that during the late spring and early summer and again during the late fall, the death-rate is low and the conception-rate is high. There is some evidence, likewise, that during the late winter and the late summer, the death-rate is high and the conception-rate low. This reciprocal

TABLE 55. COEFFICIENTS OF CORRELATION BETWEEN BIRTH-RATE AND DEATH-RATE

TIME-RELATION	THROUGH DECEMBER, 1908	THROUGH DECEMBER, 1911	THROUGH DECEMBER, 1919
Birth-rate lag 21 months	+.422	+.168	+.066
Birth-rate lag 20 months	+.347	+.079	+.046
Birth-rate lag 19 months	+.401	+.149	+.109
Birth-rate lag 18 months	+.406	+.184	+.130
Birth-rate lag 17 months	+.507	+.217	+.207
Birth-rate lag 16 months	+.423	+.200	+.168
Birth-rate lag 15 months	+.341	+.154	+.082
Birth-rate lag 14 months	+.398	+.212	+.074
Birth-rate lag 13 months	+.445	+.210	+.088
Birth-rate lag 12 months	+.553	+.282	+.122
Birth-rate lag 11 months	+.355	+.220	+.104
Birth-rate lag 10 months	+.270	+.168	+.007
Birth-rate lag 9 months	+.302	+.171	+.061
Birth-rate lag 8 months	+.290	+.186	+.103
Birth-rate lag 7 months	+.370	+.268	+.166
Birth-rate lag 6 months	+.497	+.372	+.272
Birth-rate lag 5 months	+.543	+.390	+.260
Birth-rate lag 4 months	+.550	+.402	+.189
Birth-rate lag 3 months	+.378	+.253	+.155
Birth-rate lag 2 months	+.428	+.269	+.099
Birth-rate lag 1 month	+.389	+.242	+.101
Synchronous	+.411	+.302	+.157
Birth-rate lead 1 month	+.311	+.225	+.060
Birth-rate lead 2 months	+.299	+.231	+.092
Birth-rate lead 3 months	+.381	+.262	+.104
Birth-rate lead 4 months	+.205	+.146	+.040
Birth-rate lead 5 months	+.204	+.177	+.117
Birth-rate lead 6 months	+.270	+.213	+.166
Birth-rate lead 7 months	+.351	+.275	+.237
Birth-rate lead 8 months	+.336	+.298	+.228
Birth-rate lead 9 months	+.066	+.064	+.056
Birth-rate lead 10 months	+.172	+.101	+.060
Birth-rate lead 11 months	+.229	+.146	+.053
Birth-rate lead 12 months	+.259	+.183	+.077
Birth-rate lead 13 months	+.111	+.063	+.026
Birth-rate lead 14 months	+.104	+.063	+.048
Birth-rate lead 15 months	+.235	+.076	+.032
Birth-rate lead 16 months	+.279	+.115	+.096
Birth-rate lead 17 months	+.245	+.099	+.138
Birth-rate lead 18 months	+.220	+.190	

relationship between births or conceptions and deaths appears also in the case of any great social calamity. As a war or a pestilence raises the death-rate, so likewise it depresses the birth-rate, and in estimating the social effect of either, it is of the first importance to consider not only the deaths it has caused, but also the births it has prevented."

stated that, generally speaking, influences which tend to increase deaths tend also to decrease births. We have seen, on the other hand, that the trends in both the birth-rate and the death-rate are downward. This would indicate that the combined effect of many forces affects both these series in the same manner. We have just seen that the cyclical fluctuations vary in the same direction. Only in the seasonal fluctuations do we find that inverse relationship suggested by Professor Willcox.

It is frequently suggested, apparently with reason, that the positive relationship existing between a high death-rate and a high birth-rate is the result of a high rate of infant mortality.[1] A reference to the Chart will show that the coefficients of correlation are much higher when the birth-rate lags. Now a lagging birth-rate removes, more or less effectually, the influence of a high infant mortality rate upon the general death-rate. This inference receives some corroboration from Mayo-Smith.[2] We think that

[1] G. U. Yule has found a coefficient of +.77 between general mortality and infantile mortality in England and Wales. *Introduction to Theory of Statistics* (6th ed., 1922), p. 198.

[2] *Op. cit.*, pp. 139–40. "And it is undoubtedly true that a very sudden increase in the number of births, by increasing the relative proportion of young children in a population, would be apt to increase the death-rate. Dr. Farr, however, has pointed out that if the high birth-rate continues, the age classes from ten to forty, where the mortality is the least, will gradually become well filled, so that the death-rate in such a population will be low, notwithstanding the large birth-rate. It must be remembered also that a large birth-rate ordinarily implies a large number of young married persons who, of course, are in the healthy ages.

"It seems, therefore, that the influence of the birth-rate upon the death-rate has been greatly exaggerated. The director of the official German statistics, after comparing the curve of births and deaths during a period of forty-five years comes to the following conclusion: 'It is impossible to discover any connection between the birth- and death-rates in the sense that a high birth-rate corresponds to a high death-rate in the same or subsequent years — as one might expect on account of the great infant mortality. Only in Bavaria, where the infant mortality is particularly large, it is to be observed that the level of both rates is higher at the end of the period than at the beginning. Otherwise the years with numerous births fall more com-

these data show that the cyclical fluctuations in the death-rate vary directly with the cyclical fluctuations in the birth-rate and that this direct relationship does not arise wholly or even substantially through a heavy mortality in infancy or early childhood.[1]

4. Correlation between the Stillbirth-Rate and Wholesale Prices

Table 56 provides the coefficients of correlation found by studying the relationship between the cyclical fluctu-

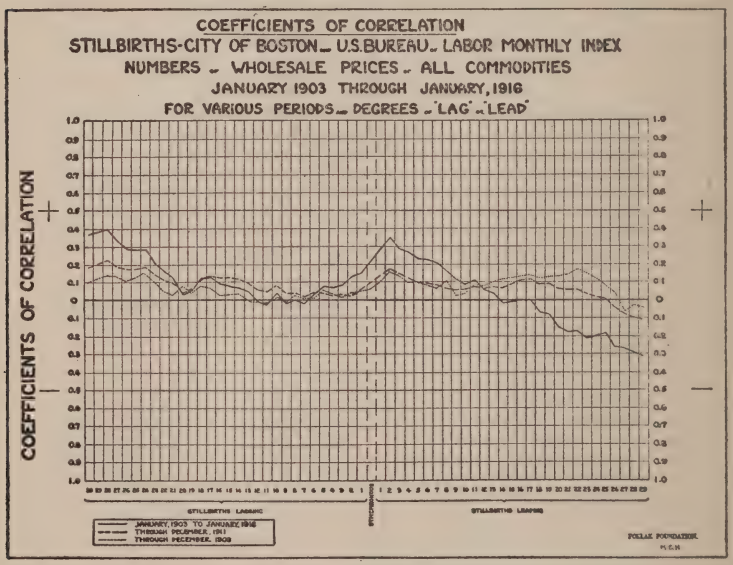
COEFFICIENTS OF CORRELATION
STILLBIRTHS-CITY OF BOSTON.. U.S.BUREAU.. LABOR MONTHLY INDEX NUMBERS .. WHOLESALE PRICES .. ALL COMMODITIES
JANUARY 1903 THROUGH JANUARY, 1916
FOR VARIOUS PERIODS.. DEGREES .. 'LAG' .. 'LEAD'
COEFFICIENTS OF CORRELATION
STILLBIRTHS LAGGING
STILLBIRTHS LEADING
JANUARY, 1903 TO JANUARY, 1916
THROUGH DECEMBER, 1911
THROUGH DECEMBER, 1909
POLLAK FOUNDATION

CHART 29

monly together with those where the death-rate is low, the low birth-rates with the high death-rates, or the low birth-rates follow the high death-rates. This seems to indicate that the economic prosperity of the year, while it increases the birth-rate decreases the death-rate.'"

[1] "This is a much higher correlation (+.77) than would arise from the mere fact that the deaths of infants form part of the general mortality, and consequently there must be a high correlation between the annual changes in the mortality of those who are over and under one year of age." (Yule, *op. cit.*, p. 198.)

TABLE 56. COEFFICIENTS OF CORRELATION BETWEEN STILLBIRTH-RATE AND WHOLESALE PRICES

TIME-RELATION	THROUGH DECEMBER, 1908	THROUGH DECEMBER, 1911	THROUGH JANUARY, 1916
Stillbirth lag 25 months	+.282	+.175	+.123
Stillbirth lag 24 months	+.283	+.187	+.155
Stillbirth lag 23 months	+.212	+.144	+.099
Stillbirth lag 22 months	+.163	+.112	+.050
Stillbirth lag 21 months	+.126	+.096	+.024
Stillbirth lag 20 months	+.127	+.036	−.074
Stillbirth lag 19 months	+.155	+.060	+.032
Stillbirth lag 18 months	+.123	+.117	+.076
Stillbirth lag 17 months	+.122	+.127	+.061
Stillbirth lag 16 months	+.090	+.123	+.022
Stillbirth lag 15 months	+.075	+.123	+.030
Stillbirth lag 14 months	+.064	+.114	+.033
Stillbirth lag 13 months	+.044	+.094	−.008
Stillbirth lag 12 months	−.008	+.057	−.011
Stillbirth lag 11 months	−.029	+.042	−.022
Stillbirth lag 10 months	+.038	+.080	+.007
Stillbirth lag 9 months	−.024	+.034	−.017
Stillbirth lag 8 months	±.000	+.038	+.026
Stillbirth lag 7 months	−.020	+.017	+.007
Stillbirth lag 6 months	+.032	+.038	+.009
Stillbirth lag 5 months	+.075	+.037	+.050
Stillbirth lag 4 months	+.068	+.020	+.023
Stillbirth lag 3 months	+.084	+.028	+.012
Stillbirth lag 2 months	+.130	+.020	+.038
Stillbirth lag 1 month	+.149	+.053	+.052
Synchronous	+.218	+.094	+.063
Stillbirth lead 1 month	+.290	+.138	+.100
Stillbirth lead 2 months	+.348	+.176	+.158
Stillbirth lead 3 months	+.289	+.148	+.136
Stillbirth lead 4 months	+.271	+.121	+.092
Stillbirth lead 5 months	+.229	+.097	+.098
Stillbirth lead 6 months	+.223	+.095	+.088
Stillbirth lead 7 months	+.203	+.083	+.065
Stillbirth lead 8 months	+.157	+.068	+.104
Stillbirth lead 9 months	+.114	+.052	+.029
Stillbirth lead 10 months	+.088	+.052	+.041
Stillbirth lead 11 months	+.108	+.072	+.081
Stillbirth lead 12 months	+.053	+.055	+.076
Stillbirth lead 13 months	+.035	+.070	+.098
Stillbirth lead 14 months	−.018	+.064	+.112
Stillbirth lead 15 months	−.011	+.089	+.118
Stillbirth lead 16 months	±.000	+.104	+.127
Stillbirth lead 17 months	±.000	+.118	+.133
Stillbirth lead 18 months	−.078	+.091	+.115
Stillbirth lead 19 months	−.086	+.092	+.129
Stillbirth lead 20 months	−.153	+.061	+.134
Stillbirth lead 21 months	−.181	+.052	+.142
Stillbirth lead 22 months	−.172	+.058	+.169
Stillbirth lead 23 months	−.210	+.032	+.148
Stillbirth lead 24 months	−.199	+.013	+.113
Stillbirth lead 25 months	−.183	+.004	+.075
Stillbirth lead 26 months	−.259	−.045	+.036
Stillbirth lead 27 months	−.271	−.075	−.070
Stillbirth lead 28 months	−.294	−.093	−.025
Stillbirth lead 29 months	−.317	−.108	−.042

ations in the stillbirth-rate and the cyclical variations in wholesale prices. These coefficients appear as Chart 29. In this Chart we notice only a general consistence between the sub-period. The maximum correlation is reached when the stillbirth-rate *leads* in the pairing with wholesale prices by two months. In that case the coefficient is +.348. Since we are dealing with wholesale prices which, on the whole, precede retail prices by two months, and with stillbirth (a fœtal death occurring after six months of gestation), we must add about eight or nine months to the period by which stillbirths lead fluctuations in retail prices. This gives a lead to *conception* of from ten to eleven months in the relationship with retail prices. It will be recalled that this is just about the time-relationship existing between live births and fluctuations in prices.[1] When we compare the size of the coefficient, however, we do not reach the same height as that provided by the live birth-rate. In the latter case, the maximum coefficient was +.705, — more than twice as large as in the case of stillbirths. This lower coefficient of correlation reflects the conditions shown in Chart 25, where the cyclical fluctuations for all of the series are shown. It will be noted very readily from that Chart that cycles in the stillbirth-rate are not so noticeable as in the live birth-rate.

5. Correlation between the Death-Rate and Wholesale Prices

Table 57 gives the coefficients of correlation reached by studying the relationship between the cyclical fluctuations in the death-rates and similar fluctuations in wholesale prices. Chart 30 shows these findings in graphic form.

[1] It is to be noted that a higher coefficient is secured when the stillbirth-rate lags twenty-eight months behind wholesale prices. This high coefficient is partly the response to running over into other cycles.

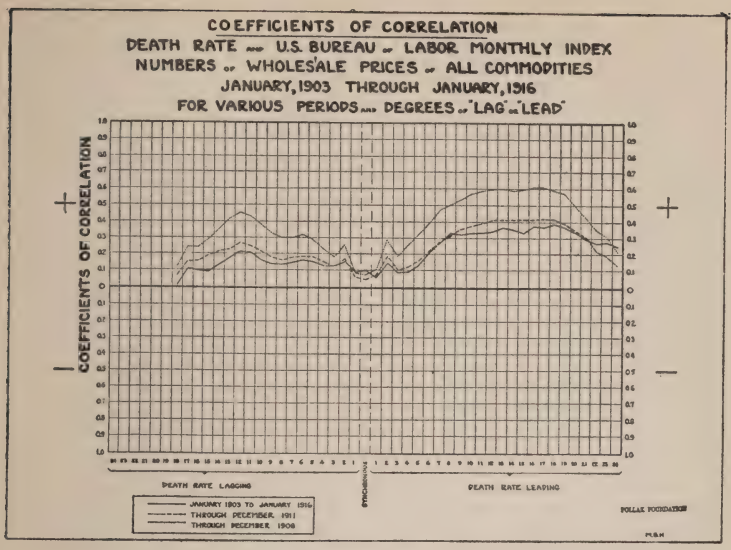

CHART 30

From the Chart we see the same consistence between various sub-periods that we found in birth-rates. We notice, too, that all the coefficients are positive, and that the coefficients are low when the curves are concurrently paired. When the curve for the death-rate either lags or leads, the coefficients rise gradually to a maximum point and then gradually decline again. In this case, also, we note that much higher coefficients are reached when the death-rate leads by from eleven to seventeen months. For that time-relationship, the coefficients vary around +.59 line — the maximum coefficient being +.613 at seventeen-months lead. We recall, at this point, the fact that for both the live birth-rate and the stillbirth-rate we found maximum correlations when these two variates were *leading* fluctuations in wholesale prices by about eleven months.

TABLE 57. COEFFICIENTS OF CORRELATION BETWEEN DEATH-RATE AND WHOLESALE PRICES

TIME-RELATION	THROUGH DECEMBER, 1908	THROUGH DECEMBER, 1911	THROUGH JANUARY, 1916
Death-rate lag 18 months	+.117	+.069	+.010
Death-rate lag 17 months	+.240	+.150	+.105
Death-rate lag 16 months	+.234	+.156	+.095
Death-rate lag 15 months	+.290	+.189	+.091
Death-rate lag 14 months	+.350	+.215	+.133
Death-rate lag 13 months	+.410	+.223	+.172
Death-rate lag 12 months	+.447	+.263	+.213
Death-rate lag 11 months	+.424	+.245	+.205
Death-rate lag 10 months	+.380	+.217	+.165
Death-rate lag 9 months	+.329	+.178	+.137
Death-rate lag 8 months	+.298	+.155	+.135
Death-rate lag 7 months	+.300	+.167	+.143
Death-rate lag 6 months	+.319	+.176	+.161
Death-rate lag 5 months	+.290	+.175	+.148
Death-rate lag 4 months	+.227	+.143	+.124
Death-rate lag 3 months	+.171	+.118	+.125
Death-rate lag 2 months	+.260	+.171	+.144
Death-rate lag 1 month	+.082	+.059	+.089
Synchronous	+.068	+.047	+.097
Death-rate lead 1 month	+.104	+.074	+.057
Death-rate lead 2 months	+.286	+.187	+.145
Death-rate lead 3 months	+.186	+.100	+.085
Death-rate lead 4 months	+.255	+.127	+.092
Death-rate lead 5 months	+.325	+.157	+.132
Death-rate lead 6 months	+.395	+.217	+.213
Death-rate lead 7 months	+.469	+.270	+.266
Death-rate lead 8 months	+.503	+.316	+.328
Death-rate lead 9 months	+.537	+.356	+.319
Death-rate lead 10 months	+.565	+.378	+.329
Death-rate lead 11 months	+.584	+.392	+.328
Death-rate lead 12 months	+.597	+.411	+.337
Death-rate lead 13 months	+.599	+.410	+.362
Death-rate lead 14 months	+.587	+.409	+.354
Death-rate lead 15 months	+.596	+.409	+.332
Death-rate lead 16 months	+.611	+.410	+.376
Death-rate lead 17 months	+.613	+.416	+.365
Death-rate lead 18 months	+.589	+.408	+.392
Death-rate lead 19 months	+.562	+.392	+.366
Death-rate lead 20 months	+.496	+.348	+.331
Death-rate lead 21 months	+.423	+.299	+.295
Death-rate lead 22 months	+.353	+.218	+.271
Death-rate lead 23 months	+.307	+.189	+.276
Death-rate lead 24 months	+.212	+.132	+.245

6. Correlation of the Death-Rate and Employment in Massachusetts

Table 58 contains the coefficients of correlation found by comparing the cyclical fluctuations in the death-rate with cyclical variations in employment in Massachusetts. These coefficients are depicted in Chart 31. Herein we

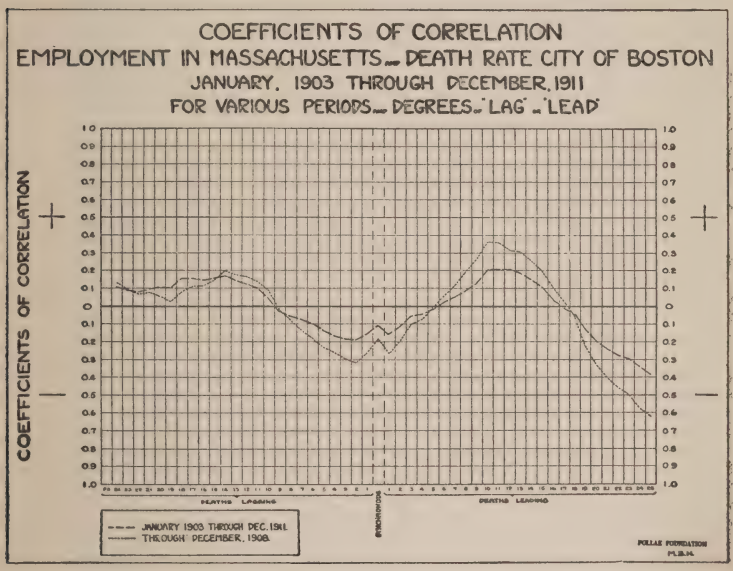

CHART 31

notice a sensible degree of consistence between the two curves. There is also a certain smoothness in the flow of the curves. We note that, when the curves are paired concurrently, the coefficient of correlation is low and negative. Then, on each side of concurrence, the curves rise to a positive coefficient and then decline. This decline brings the coefficients below the line when the curves are paired so that the death-rate leads in the timing. We have just noted that when the death-rate is paired concurrently in

TABLE 58. COEFFICIENTS OF CORRELATION BETWEEN DEATH-RATE AND EMPLOYMENT

TIME-RELATION	THROUGH DECEMBER, 1908	THROUGH DECEMBER, 1911
Death-rate lag 24 months	+.135	+.107
Death-rate lag 23 months	+.093	+.092
Death-rate lag 22 months	+.068	+.080
Death-rate lag 21 months	+.070	+.095
Death-rate lag 20 months	+.055	+.106
Death-rate lag 19 months	+.030	+.099
Death-rate lag 18 months	+.081	+.154
Death-rate lag 17 months	+.112	+.159
Death-rate lag 16 months	+.114	+.145
Death-rate lag 15 months	+.147	+.155
Death-rate lag 14 months	+.195	+.172
Death-rate lag 13 months	+.174	+.145
Death-rate lag 12 months	+.163	+.124
Death-rate lag 11 months	+.134	+.099
Death-rate lag 10 months	+.087	+.047
Death-rate lag 9 months	−.020	−.026
Death-rate lag 8 months	−.080	−.057
Death-rate lag 7 months	−.133	−.078
Death-rate lag 6 months	−.181	−.099
Death-rate lag 5 months	−.227	−.136
Death-rate lag 4 months	−.258	−.164
Death-rate lag 3 months	−.293	−.182
Death-rate lag 2 months	−.314	−.188
Death-rate lag 1 month	−.260	−.157
Synchronous	−.186	−.111
Death-rate lead 1 month	−.266	−.159
Death-rate lead 2 months	−.191	−.113
Death-rate lead 3 months	−.108	−.055
Death-rate lead 4 months	−.073	−.047
Death-rate lead 5 months	−.013	−.019
Death-rate lead 6 months	+.060	+.022
Death-rate lead 7 months	+.118	+.052
Death-rate lead 8 months	+.193	+.085
Death-rate lead 9 months	+.262	+.127
Death-rate lead 10 months	+.361	+.201
Death-rate lead 11 months	+.360	+.208
Death-rate lead 12 months	+.317	+.203
Death-rate lead 13 months	+.306	+.185
Death-rate lead 14 months	+.261	+.153
Death-rate lead 15 months	+.197	+.103
Death-rate lead 16 months	+.099	+.034
Death-rate lead 17 months	+.028	−.005
Death-rate lead 18 months	−.058	−.046
Death-rate lead 19 months	−.212	−.129
Death-rate lead 20 months	−.323	−.195
Death-rate lead 21 months	−.400	−.239
Death-rate lead 22 months	−.456	−.272
Death-rate lead 23 months	−.496	−.300
Death-rate lead 24 months	−.570	−.338
Death-rate lead 25 months	−.620	−.384

time with employment we reach negative coefficients. This would indicate that for this time-relationship, the death-rate varies *directly with unemployment.* The highest coefficient is found when the death-rate leads by twenty-five months. In that case it is −.620. It may well be, on the other hand, that part of this large coefficient is the result of an overlapping of cycles. If that be true, the maximum correlation (+.361) is found when the death-rate leads employment by ten months. This would suggest the interpretation that ten months following cyclical fluctuations in the death-rate, cyclical variations in *unemployment* occur in the opposite direction.

Professor Ogburn and Miss Thomas[1] found for death-rates for certain States a correlation of +0.57, and with cycles from nine-year moving averages, +0.63. These results were so surprising to those students that, after studying the situation for England, they write that "these results increase our skepticism regarding the existence of a significant correlation between the death-rates and the business cycle." Our own findings of an inverse relationship are closer to expectations. Von Firks[2] definitely postulates a close connection between the death-rate and economic conditions. Mayo-Smith[3]

[1] *Loc. cit.*, pp. 335–38.

[2] "Missernten und der dadurch veranlasste Mangel an Nahrungsmitteln erhöhen in einzelnen Jahren die Sterbeziffer betrachtlich, ebenso Seuchen und Kriege. In Findland stieg die Sterbeziffer in den Notjahren 1867 und 1868 auf 39, 1 bezw., 79,4, in Deutschland und Oesterreich im Jahre 1866 infolge der Cholera auf 30,6 bezw., 40,9, in Galizien durch Cholera and innere Wirren in den Jahren 1847 und 1848 auf 74,4 bezw., 62,4, in Cholerajahren 1855, und 1873 auf 60,1 bezw., 53,6, in Ungarn zufolge Cholera im Jahre 1873 auf 63,2, in Preussen in den Cholerajahren 1848, 1849, 1852, 1855, 1866 und 1873 auf 32,1 bezw., 28,9, 31, 3, 30, 6, 34, 1 und 28 in Deutschen Reiche und Frankreich 1871 infolge des Krieges und einer in Frankreich entstandenen, durch Kreigsgefangene auch nach Deutschland übertragenen Pockenepidemie auf 38,5 bezw., 34, 8, in Serbien in Kriegsjahre 1876 auf 48,2." (*Op. cit.* pp. 172–73.)

[3] *Op. cit.*, p. 138.

states that "many attempts have been made to connect the price of food directly with the death-rate. The results, however, are not altogether satisfactory. For instance, in Germany they have traced the price of rye and the corresponding curve for deaths from 1841 to 1885. During the first ten or fifteen years there is close correspondence. When the price of rye rose from 120 marks for 1000 kilos in 1844 to 225 marks in 1847, the death-rate rose from 26 per 1000 in 1844 to 30.5 per 1000 in 1848; and when the price of rye sank to its former level a year later, the death-rate also resumed its usual level. We have here a striking example of the effect of a sudden and distressful failure of the food supply. But the next period of scarcity in 1853–54, which raised the price of rye even higher than in 1847, and resulted in both a decreased marriage- and birth-rate, brought about a fluctuating death-rate, which rose to only 29.5 and sank immediately thereafter. Since that time the price of rye and the death-rate in Germany have shown no direct connection with each other." Dr. Huntington[1] postulates a close connection between death-rates and business conditions. In the concluding Chapter of this book, we shall have something further to say concerning the time-relationship of these variables to which Dr. Huntington has alluded.

7. Correlation of Marriages and Wholesale Prices

The relationship between marriage and economic situations has long interested students and mankind in general. Our own discussions are of interest because they concern themselves with monthly fluctuations. Table 59 provides the coefficients of correlation reached by compar-

[1] Ellsworth Huntington, *World Power and Evolution* (New Haven, 1919), pp. 25–50. "The statistics from 1870 to the Great War show that a high death-rate precedes prosperity."

ing cyclical fluctuations in the monthly number of marriages with similar fluctuations in wholesale prices. Chart 32 shows these coefficients graphically. The maximum co-

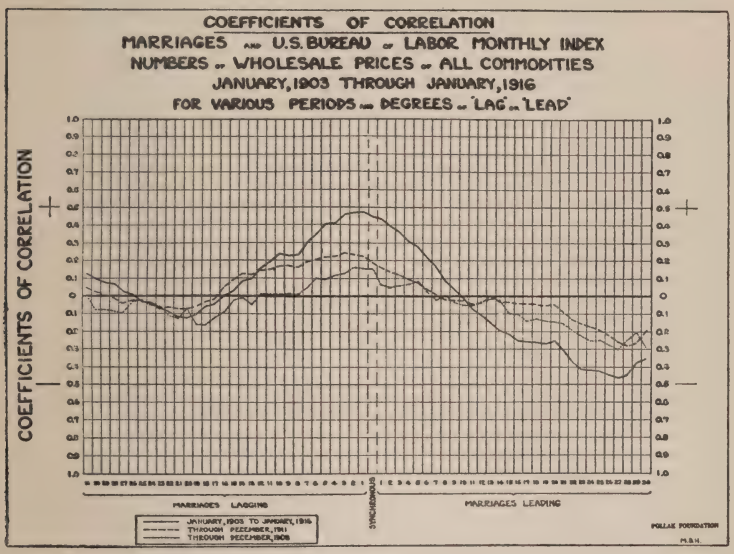
COEFFICIENTS OF CORRELATION
MARRIAGES AND U.S. BUREAU OF LABOR MONTHLY INDEX NUMBERS OF WHOLESALE PRICES OF ALL COMMODITIES
JANUARY, 1903 THROUGH JANUARY, 1916
FOR VARIOUS PERIODS AND DEGREES OF 'LAG' AND 'LEAD'
COEFFICIENTS OF CORRELATION
MARRIAGES LAGGING
SYNCHRONOUS
MARRIAGES LEADING
JANUARY, 1903 TO JANUARY, 1916
THROUGH DECEMBER, 1911
THROUGH DECEMBER, 1908

CHART 32

efficient of correlation is found when marriages lag one month behind wholesale prices. We have reason, therefore, to conclude that there is a direct relationship between these two variables.[1] Notice how the coefficients diminish on both sides of concurrence. Interestingly enough, the coefficients become negative when the marriage curve lags or leads sufficiently. But in neither case does it reach the magnitude found when the curves are directly paired. It is interesting to refer to our findings on seasonal correlation. There we found that months of

[1] There is, of course, a high positive correlation between prices and employment. See Persons, *op. cit.*, pp. 184–85, for the relation between prices and other series reflecting business conditions.

TABLE 59. COEFFICIENTS OF CORRELATION BETWEEN MARRIAGES AND WHOLESALE PRICES

TIME-RELATION	THROUGH DECEMBER, 1908	THROUGH DECEMBER, 1911	THROUGH JANUARY, 1916
Marriage lag 25 months	−.037	−.032	−.032
Marriage lag 24 months	−.039	−.042	−.045
Marriage lag 23 months	−.071	−.073	−.063
Marriage lag 22 months	−.093	−.063	−.112
Marriage lag 21 months	−.119	−.071	−.127
Marriage lag 20 months	−.124	−.074	−.077
Marriage lag 19 months	−.104	−.060	−.162
Marriage lag 18 months	−.064	−.038	−.167
Marriage lag 17 months	−.051	−.020	−.122
Marriage lag 16 months	+.002	+.051	−.096
Marriage lag 15 months	+.029	+.091	−.027
Marriage lag 14 months	+.086	+.124	−.010
Marriage lag 13 months	+.097	+.119	−.050
Marriage lag 12 months	+.157	+.144	+.005
Marriage lag 11 months	+.192	+.150	+.006
Marriage lag 10 months	+.238	+.171	+.007
Marriage lag 9 months	+.229	+.175	+.013
Marriage lag 8 months	+.233	+.160	+.004
Marriage lag 7 months	+.301	+.198	+.047
Marriage lag 6 months	+.346	+.206	+.098
Marriage lag 5 months	+.400	+.221	+.091
Marriage lag 4 months	+.410	+.228	+.118
Marriage lag 3 months	+.456	+.239	+.126
Marriage lag 2 months	+.468	+.230	+.159
Marriage lag 1 month	+.469	+.223	+.154
Synchronous	+.444	+.190	+.151
Marriage lead 1 month	+.432	+.162	+.063
Marriage lead 2 months	+.397	+.136	+.047
Marriage lead 3 months	+.362	+.119	+.057
Marriage lead 4 months	+.311	+.097	+.063
Marriage lead 5 months	+.279	+.078	+.081
Marriage lead 6 months	+.214	+.041	+.022
Marriage lead 7 months	+.169	+.011	+.028
Marriage lead 8 months	+.090	−.021	+.005
Marriage lead 9 months	+.041	−.024	−.036
Marriage lead 10 months	−.017	−.027	−.057
Marriage lead 11 months	−.072	−.044	−.057
Marriage lead 12 months	−.111	−.041	−.038
Marriage lead 13 months	−.150	−.000	−.018
Marriage lead 14 months	−.194	−.037	−.030
Marriage lead 15 months	−.217	−.035	−.098
Marriage lead 16 months	−.249	−.043	−.104
Marriage lead 17 months	−.253	−.044	−.143
Marriage lead 18 months	−.260	−.046	−.130
Marriage lead 19 months	−.268	−.055	−.143
Marriage lead 20 months	−.249	−.046	−.144
Marriage lead 21 months	−.311	−.093	−.152
Marriage lead 22 months	−.372	−.136	−.198
Marriage lead 23 months	−.412	−.158	−.224
Marriage lead 24 months	−.418	−.178	−.255
Marriage lead 25 months	−.421	−.193	−.249
Marriage lead 26 months	−.443	−.224	−.278
Marriage lead 27 months	−.459	−.260	−.303
Marriage lead 28 months	−.442	−.280	−.252

much employment are peak months in marriages. In this case, too, the maximum correlation occurred with concurrent pairing. We are urged to the inference then that seasonal and cyclical variations in marriages vary directly with economic conditions.

The connection between marriage and economic conditions has been the subject of many researches. It seems wise to review their findings here. The younger Mill[1] noted "that according to all experience a great increase invariably takes place in the number of marriages in seasons of cheap food and full employment." By seasons Mill does not mean exactly what we have connoted by seasonal variation. Mill has in mind fluctuations of longer duration. Fawcett[2] noted an invariable increase in the number of marriages as the price of bread declined. Bodio[3] arrived at a similar conclusion. Although agreeing with these writers upon the connection between hard times and a low marriage-rate, Ogle[4] discovered the fact that the correlation between marriage and the price of bread was a positive one, rather than the inverse one noted by Mill, Fawcett, and Bodio. He urged that the high cost of bread was a result of and indicated increased industrial activity. His conclusion is that marriages increase and decline with the "amount of industrial employment, which in its turn is determined by the briskness of trade, as measured by the values of exports, which also rise and fall concomitantly, and produce by their effects upon freights a simultaneous rise and fall in the price of wheat."[5] It has been suggested that for England

[1] John Stuart Mill, *Principles of Political Economy* (1st ed., Boston, 1848), vol. 1, p. 413.

[2] Henry Fawcett, *Manual of Political Economy* (4th ed., London, 1874), p. 143.

[3] Bodio, *loc. cit.*, p. 156.

[4] Ogle, *loc. cit.*, pp. 256–63.

[5] "It is well known that the English marriage-rate was negatively correlated with wheat prices in the earlier part of the nineteenth century and was

foreign commercial relations must be included in a determination of the condition of material well-being.[1] The Bavarian statistician Hermann [2] states that "the number of marriages in any period expresses the expectation of economic prosperity prevailing at that time, and expresses this the more clearly, the greater the degree of economic freedom in the country." Meitzen provides an interesting chart, which utilizes the average price in marks of one hectolitre of rye as a correlative to the number of marriages per 100,000 inhabitants for four German provinces from 1835 through 1865, showing positive correlation with a lag in the marriage-rate.[3] Beveridge [4] gives a chart showing the marriage-rate in the United Kingdom in which the correlatives are the bank-rate,

positively correlated with exports, clearing-house returns and so on in the latter part." (A. C. Pigou, *The Economics of Welfare* (London, 1920), p. 60.) "Hence there was slight negative correlation between the marriage-rate and price of wheat before 1864, that is, the marriage-rate fell when wheat rose; but since 1864, there is better evidence that the marriage-rate rises when wheat rises. The marriage-rate and foreign trade were quite uncorrelated before 1864, and show only slight correlation at more recent dates; the odds against the correspondence between the observed figures, since 1875, arising without causal connection, are only about 4 to 1, if we assume that the figures for each year are independent of the next." (A. L. Bowley, *The Elements of Statistics* (3d ed., London, 1908), p. 322.) V. Pareto has suggested that the value of exports and the coal mined, together with some agricultural feature, should be utilized as a correlative. See his "Quelques examples d'application des méthodes d'interpolation à la statistique," *Journal de la Société de Statistique de Paris* (November, 1897), pp. 367–78; also see by *ibid.*, *Cours d'économie politique* (1907), p. 88; also Alfred Marshall, *Principles of Economics* (8th ed., London, 1920), p. 190; see also the comparison between the marriage-rate and harvests in Sweden for almost a century and a half by Rawson-Rawson in the *Journal of the Royal Statistical Society*, December, 1885.

[1] G. Cauderlier, *Les Lois de la population et leur application à la Belgique* (Brussels, 1900).

[2] Mayo-Smith, *op. cit.*, p. 100; see also the recent article by George Elliot Howard, "The Matrimonial Barometer in Times of War and Peace," *Journal of Applied Sociology*, vol. VII, No. 3 (January–February, 1923), pp. 99–108.

[3] Meitzen, *op. cit.*, chart opposite page 138.

[4] Beveridge, *op. cit.*, p. 44.

employment, foreign trade, indoor pauperism, the capital of new companies registered, and the consumption of beer. A direct relationship between the marriage-rate and most of these correlatives is apparent. Tugan-Baranowsky[1] has presented a series of charts in which marriages are compared with pauperism for the years 1823–50 and 1871–96. In his memorable study "On the Correlation of the Marriage-Rate with Foreign Trade," Hooker[2] found that "in the case of exports and marriage-rate, for instance, it appears that a maximum coefficient (+.86) is obtained by correlating the marriages with the exports of half a year earlier." He also "found a high correlation between the wave-like movements in the marriage-rate, and those in imports, in exports, and in the clearing-house returns, and a somewhat smaller correlation with the movements in

[1] M. Tugan-Baranowsky, "Die Sozialen Wirkungen der Händelkrisen in England," *Archiv für soziale Gesetzgebung*, vol. xv. Yule has also studied the correlation between the marriage-rate and pauperism. See "Investigation into the Causes of Changes in Pauperism in England," *Journal of the Royal Statistical Society*, vol. LXIII (1899), p. 265.

[2] R. H. Hooker, *Journal of the Royal Statistical Society*, vol. LXIV (1901), p. 488. This memoir is memorable also because it utilized a method of variate differences. Hooker was not the first one to use it, however. F. E. Cave first used it in working with barometric correlations. (*Proceedings Royal Society*, vol. LXXIV (1904), p. 396.) Hooker, as mentioned above, followed shortly thereafter. Both of these writers used only first differences. In 1914 "Student" generalized the method (*Biometrika*, vol. x, p. 179), and in the same year Dr. O. Anderson presented formulæ for the determination of the probable error of correlations of successive differences (pp. 269–79). In the same issue (pp. 340–55) B. M. Cave and Karl Pearson illustrate the use of this method in employing Italian economic data published by Mortara, February, 1914, in *Giornale degli Economisti e Rivista di Statistica*. In the same volume (pp. 488–506) Elderton and Pearson, applying the method to certain demographic data, conclude that the Variate Difference Method annuls the environmental factor in a better fashion than the method of partial correlation. In the *Quarterly Publications of the American Statistical Association*, vol. XVI (1916), p. 141, Persons has applied the method to certain fundamental economic series and shows that the method has certain possibilities not recognized in the earlier works and also serious defects for short series. In vol. XIV of *Biometrika* (April, 1923), pp. 281–309, Pearson and Elderton reply to certain criticisms made by both Yule and Persons, denying the former and largely admitting the latter.

the price of wheat. Further, he not only correlated the deviation of the marriage-rate with the deviation of the measure of trade in the same year, but also with that in the years following and preceding. Thus the correlation of the deviation in marriage-rate with that of the amount of clearing in the following year is −0.19, in the same year +0.47, in the year before +0.92, in the year but one before +0.76; interpolating between these figures, the maximum correlation would appear to subsist between the marriage-rate and the clearing of about a year and a quarter before. It would appear, then, that the movement of the marriage-rate lags by about a year and a quarter behind the clearing-house returns." [1] Lucien March [2] reached a correlation of −.73 in comparing the marriage-rate and unemployment. Dr. Davies [3] found the coefficient of correlation between the wholesale price cycle and the marriage-rate for certain states to be +0.67 for the period 1887–1906. Professor Ogburn and Miss Thomas [4] reach a coefficient of correlation of +0.66 with concurrent pairing with cycles of business indexes. "Although in general the marriage-rate increases in prosperity and diminishes in depression, this is rather noticeably not true in the year 1918. The marked drop in the marriage-rate in this very prosperous year is thought to be due to the extraordinary conditions of war-time. If we omit from the correlation table the data for the year 1918, the correlation becomes +0.87." This corroboration leaves little doubt that marriages increase with prosperity and decrease with adversity. This is shown in annual fluctuations, seasonal vari-

[1] G. U. Yule, "Method of Correlation to Social and Economic Statistics," *Journal of the Royal Statistical Society*, vol. LXXII (1909), p. 725.

[2] Lucien March, "Comparaison numérique de courbes statistiques," *Journal de la Société de Statistique de Paris* (1905), pp. 255, 306.

[3] Davies, *loc. cit.*, p. 111.

[4] Ogburn and Thomas, *loc. cit.*, pp. 331, 334.

ations, and in cyclical fluctuations in data which come in the shape of monthly reports.

8. Correlation of Divorces and Wholesale Prices

Table 60 reflects the coefficients of correlation reached when comparing the cyclical fluctuations in the number of divorce libels filed and similar fluctuations in wholesale prices. These coefficients are pictured in Chart 33. It

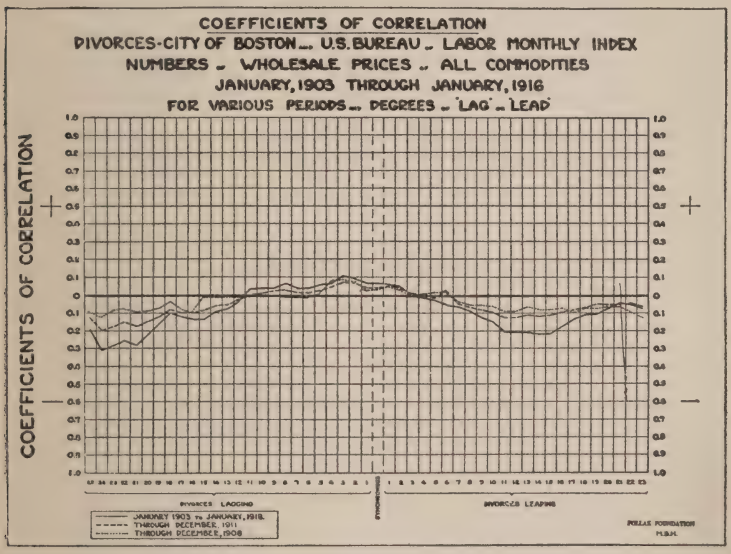
COEFFICIENTS OF CORRELATION
DIVORCES-CITY OF BOSTON — U.S. BUREAU — LABOR MONTHLY INDEX NUMBERS — WHOLESALE PRICES — ALL COMMODITIES
JANUARY, 1903 THROUGH JANUARY, 1916
FOR VARIOUS PERIODS — DEGREES — 'LAG' — LEAD
COEFFICIENTS OF CORRELATION
DIVORCES LAGGING
DIVORCES LEADING
JANUARY 1903 TO JANUARY, 1918.
THROUGH DECEMBER, 1911
THROUGH DECEMBER, 1908

CHART 33

will be noted that the three curves are consistent throughout their flow; there is also a certain degree of regularity to which we have previously alluded with reference to other portions of this study. It will be seen, however, that the coefficients are not as strong as those found when we analyzed the covariation between other social occurrences. The coefficients are positive and low for pairings which are either concurrent or close to such a time-relationship.

TABLE 60. COEFFICIENTS OF CORRELATION BETWEEN DIVORCE AND WHOLESALE PRICES

TIME-RELATION	THROUGH DECEMBER, 1908	THROUGH DECEMBER, 1911	THROUGH JANUARY, 1916
Divorce lag 25 months	−.192	−.126	−.096
Divorce lag 24 months	−.308	−.201	−.123
Divorce lag 23 months	−.283	−.180	−.086
Divorce lag 22 months	−.258	−.158	−.077
Divorce lag 21 months	−.283	−.173	−.093
Divorce lag 20 months	−.224	−.150	−.087
Divorce lag 19 months	−.162	−.122	−.069
Divorce lag 18 months	−.099	−.082	−.037
Divorce lag 17 months	−.121	−.101	−.082
Divorce lag 16 months	−.135	−.101	−.099
Divorce lag 15 months	−.135	−.085	−.005
Divorce lag 14 months	−.092	−.058	−.003
Divorce lag 13 months	−.077	−.056	−.004
Divorce lag 12 months	−.030	−.029	−.007
Divorce lag 11 months	+.026	+.002	±.000
Divorce lag 10 months	+.033	+.012	±.000
Divorce lag 9 months	+.036	+.019	±.000
Divorce lag 8 months	+.062	+.024	−.002
Divorce lag 7 months	+.036	+.012	−.002
Divorce lag 6 months	+.035	+.013	−.007
Divorce lag 5 months	+.052	+.026	+.009
Divorce lag 4 months	+.065	+.042	+.083
Divorce lag 3 months	+.108	+.072	+.087
Divorce lag 2 months	+.090	+.066	+.075
Divorce lag 1 month	+.063	+.040	+.028
Synchronous	+.061	+.040	+.030
Divorce lead 1 month	+.059	+.046	+.045
Divorce lead 2 months	+.047	+.045	+.027
Divorce lead 3 months	±.000	+.012	+.009
Divorce lead 4 months	−.012	+.001	+.008
Divorce lead 5 months	−.024	−.005	+.012
Divorce lead 6 months	−.055	+.030	+.026
Divorce lead 7 months	−.062	−.047	−.037
Divorce lead 8 months	−.091	−.060	−.053
Divorce lead 9 months	−.125	−.080	−.056
Divorce lead 10 months	−.152	−.097	−.063
Divorce lead 11 months	−.203	−.122	−.089
Divorce lead 12 months	−.211	−.129	−.091
Divorce lead 13 months	−.210	−.110	−.063
Divorce lead 14 months	−.221	−.120	−.082
Divorce lead 15 months	−.216	−.113	−.081
Divorce lead 16 months	−.175	−.091	−.078
Divorce lead 17 months	−.134	−.078	−.096
Divorce lead 18 months	−.109	−.069	−.071
Divorce lead 19 months	−.106	−.072	−.077
Divorce lead 20 months	−.077	−.049	−.071
Divorce lead 21 months	−.042	−.044	−.068
Divorce lead 22 months	−.054	−.048	−.097
Divorce lead 23 months	−.078	−.062	−.132

From the time when the divorce curve lags by eleven months behind the wholesale prices curve until the time when the divorce curve leads by two months, the coefficients are *all positive but very low;* in only one case the coefficient goes to 0.108. Note well that the coefficients are all *negative* when they become large enough to be what the biometric school terms sensible. The coefficients begin to become larger when the divorce curve begins to lag twenty months and more. The maximum correlation is reached when the divorce curve lags just twenty-four months behind wholesale price fluctuations; in that case −0.308 is found. (It should be noted, however, that the coefficients are sensible when the divorce curve leads by from eleven to sixteen months. In that case the coefficients vary from −0.203 to −0.221.) It is worth while noting that we reached the very high coefficient of −0.7692 when correlating the seasonal indexes of unemployment and divorce with a five-months lag. This sign can be altered by speaking of employment so that we secure a positive correlation. Our findings suggest, then, that when wholesale prices have reached the high points of their cyclical fluctuations, divorce libels are at the low points of theirs. Note, however, that the maximum coefficients reached in this study of divorce are far lower than those maximum coefficients reached in other comparisons. We may safely conclude, therefore, that divorces are not as sensitive, as are such human incidents as births, deaths, and marriages, when compared with economic conditions and influences.

The correlational calculus has not been applied as frequently to the study of divorces as it has to other demographic series. Professor Ogburn and Miss Thomas [1]

[1] *Loc. cit.*, p. 334. The present writer doubts the propriety of the use of the nine-year moving average in the computation of the coefficient of correlation. The smoothness resulting from such a powerful interpolation formula is possibly accountable for the heavy coefficient which surprised even the

found a coefficient of +0.70 for the forty years, 1867–1906, using as a correlative a business-cycle curve constructed from nine-year moving-average trends. Strangely enough, however, the same writers find a lower coefficient when the divorce-rate lags one year, in which case the coefficient dropped to +0.58. Now it must be noted that Professor Ogburn and Miss Thomas are dealing with divorces *actually granted*. If any causal connection between business and divorce-rates is even to be suspected, there must be a time gap between the two, since there is always delay in the offices of attorneys and in the whole court procedure. For this reason, in the present study, we deal with the divorce libels filed, since in that manner we exclude immediately all court delays. It may be assumed that the delay in the offices of attorneys is more or less similar for most of these cases; such would not be the case with the delays in the courts. In noting the rather heavy coefficient secured by these investigators this must be borne in mind. This doubt existed in the minds of the investigators, for they write that "the tendency to secure more divorces in prosperity and fewer divorces in business depression is quite marked, and this conclusion is perhaps surprising. The reason is not clear, although the economic argument is clearer than the psychological. The fact that divorces are expensive, involving lawyers' and court fees and perhaps alimony, may be the reason for relatively

investigators. In this connection it is worth noting that when the same writers calculate the coefficient for thirteen States for the period ending 1920, it declines to +0.33. "The lack of correspondence between the divorce cycles of the thirteen States and the business cycles appears to be greater for the earlier years, however, than for the later years. Also, from an inspection of the curves of divorce-rates as published in the census volumes for separate sections of the United States, such as the South Atlantic States and the North Central States, it appears that there is a less close correspondence in fluctuations with the business cycle than there is for the Nation as a whole. Just why these samples should show lower correspondences than the whole, we do not know. Possible causes may be changes in laws, migrations, changes in residence, or the influence of crop cycles."

more divorces in times of business prosperity." [1] Dr. Davies [2] concludes that "there is probably also some degree of positive correlation between the marriage- and divorce-rates, though because of irregularities in the lag it cannot easily be given numerical expression."

Almost a generation ago, Professor Willcox [3] alluded to the connection between fluctuations in the divorce-rate and business enterprise. For the twenty years, 1866–86, he called attention to the low divorce-rates between 1873–79 and 1884–86, which he noted to be years of depression.

9. Summary of Cyclical Correlations

We have discussed so far the eight series of correlations between the series which we have been analyzing. Chart 34 presents all of the preceding correlational charts simultaneously. The following tabulation presents in summary form the coefficients of correlation reached when studying the correlation between cyclical fluctuations:

Paired Variables	Correlation Coefficient	Time-Relationship
Birth-rate and wholesale prices....	+.705	*Conceptions* lead by 8 months
Birth-rate and unemployment.....	+.696	Births lead by 17 months
Birth-rate and death-rate.....	+.553	Births lag by 12 months
Stillbirth-rate and wholesale prices	+.348	Stillbirth leads by 2 months
Death-rate and wholesale prices...	+.613	Deaths lead by 17 months
Death-rate and unemployment....	−.361	Deaths lead by 10 months[a]
Marriage and wholesale prices.....	+.469	Marriage lagging by 1 month
Divorce and wholesale prices.....	−.308	Divorce lagging by 24 months

[a] When the death-rate leads by 25 months, the coefficient is +.620.

[1] Professor Ogburn and Miss Thomas suggest that a knowledge of the correlation between business cycles and desertion would be suggestive. The present writer has in preparation just such comparisons for all of the desertion cases occurring among the Jewish residents in New York City which are reported to the National Desertion Bureau. Using as a correlative the cyclical fluctuations in Unemployment in Clothing and Textiles in New York State, he reaches a correlation of — 0.2679 when desertions lead by two months. It may well be that employees note an oncoming depression slightly before the time when it is reflected in employment data. See the *Jewish Social Service Quarterly*, vol. 1, No. 1 (February, 1924), pp. 3–33; No. 2 (May, 1924), pp. 30–62.

[2] *Loc. cit.*, p. 114.

[3] *Op. cit.*, p. 23.

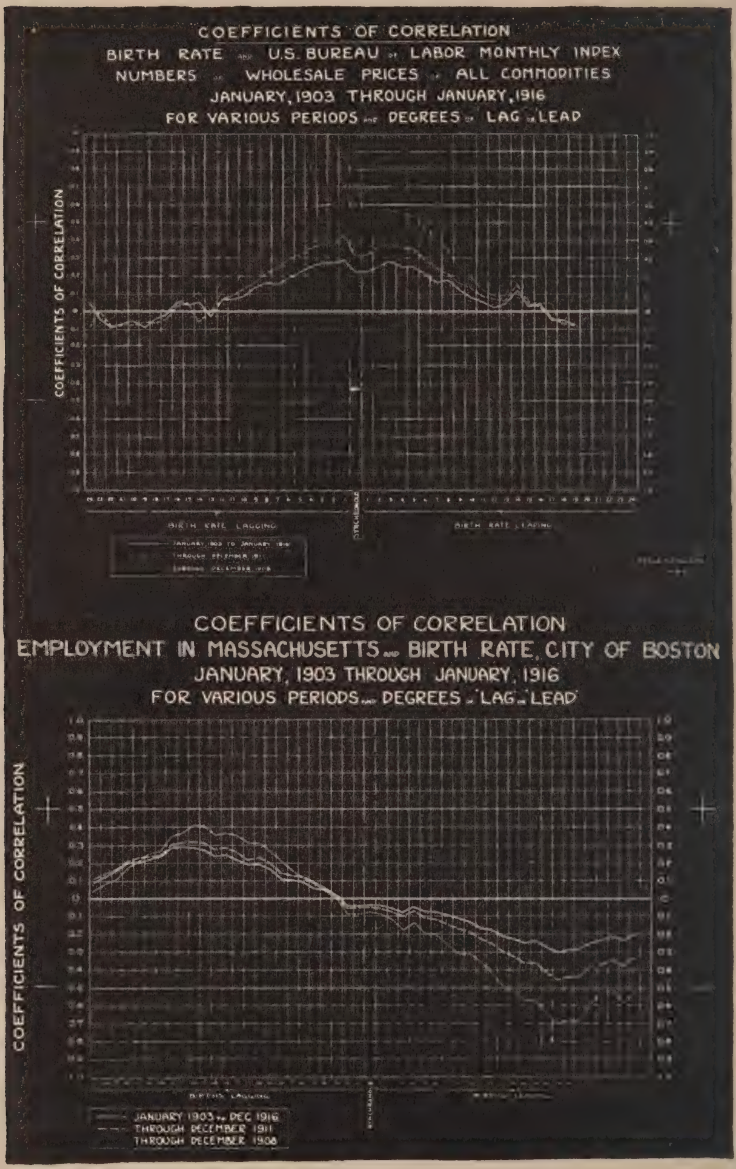
COEFFICIENTS OF CORRELATION
BIRTH RATE AND U.S. BUREAU OF LABOR MONTHLY INDEX NUMBERS OF WHOLESALE PRICES OF ALL COMMODITIES
JANUARY, 1903 THROUGH JANUARY, 1916
FOR VARIOUS PERIODS AND DEGREES OF LAG OR LEAD
COEFFICIENTS OF CORRELATION
BIRTH RATE LAGGING
BIRTH RATE LEADING
COEFFICIENTS OF CORRELATION
EMPLOYMENT IN MASSACHUSETTS AND BIRTH RATE, CITY OF BOSTON
JANUARY, 1903 THROUGH JANUARY, 1916
FOR VARIOUS PERIODS AND DEGREES OF LAG OR LEAD
COEFFICIENTS OF CORRELATION
JANUARY 1903 to DEC 1916
THROUGH DECEMBER 1911
THROUGH DECEMBER 1908

CHART 34a

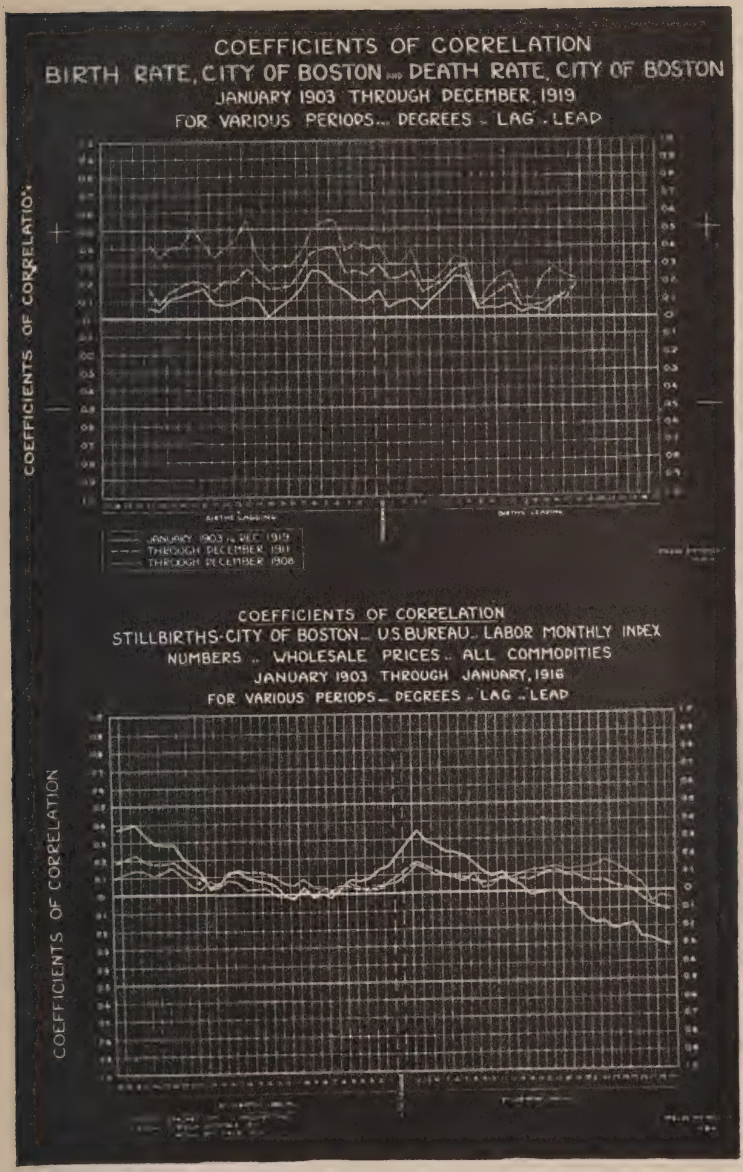
COEFFICIENTS OF CORRELATION
BIRTH RATE, CITY OF BOSTON ... DEATH RATE, CITY OF BOSTON
JANUARY 1903 THROUGH DECEMBER, 1919
FOR VARIOUS PERIODS ... DEGREES - LAG - LEAD
COEFFICIENTS OF CORRELATION
JANUARY 1903 TO DEC. 1919
THROUGH DECEMBER 1911
THROUGH DECEMBER 1908
COEFFICIENTS OF CORRELATION
STILLBIRTHS-CITY OF BOSTON ... U.S. BUREAU ... LABOR MONTHLY INDEX
NUMBERS ... WHOLESALE PRICES ... ALL COMMODITIES
JANUARY 1903 THROUGH JANUARY, 1916
FOR VARIOUS PERIODS ... DEGREES - LAG - LEAD
COEFFICIENTS OF CORRELATION

CHART 34b

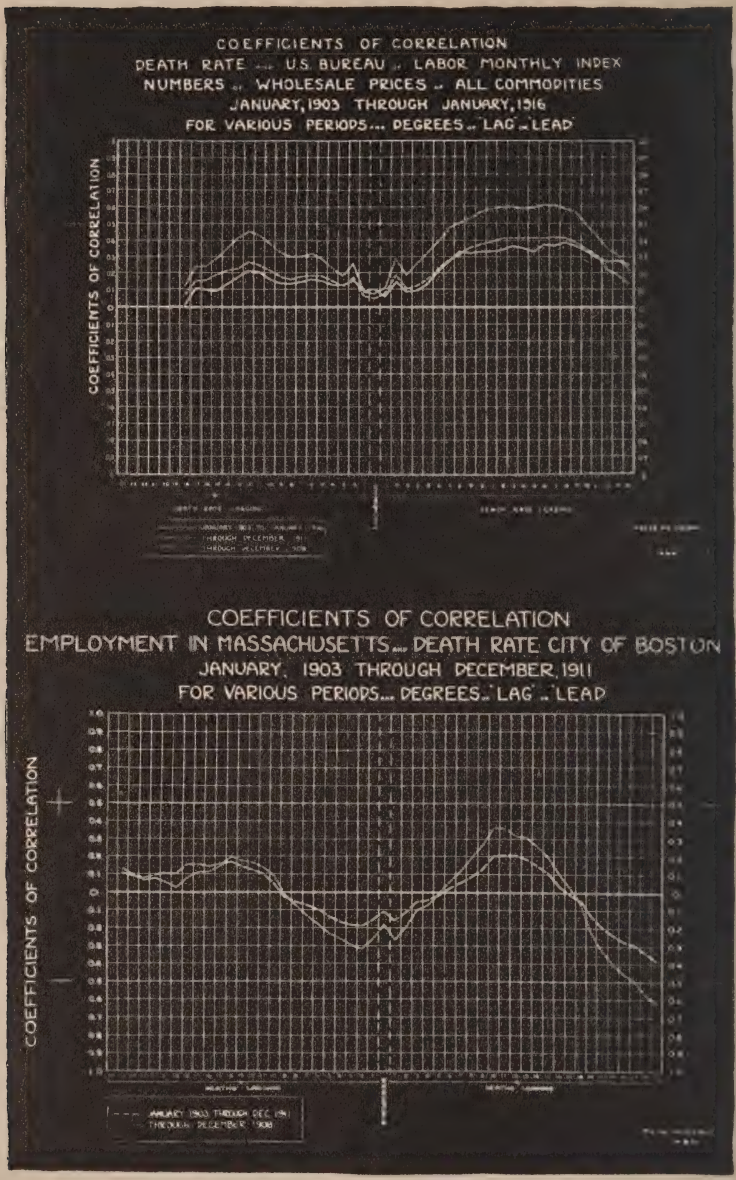
COEFFICIENTS OF CORRELATION
DEATH RATE ... U.S. BUREAU .. LABOR MONTHLY INDEX
NUMBERS .. WHOLESALE PRICES .. ALL COMMODITIES
JANUARY, 1903 THROUGH JANUARY, 1916
FOR VARIOUS PERIODS... DEGREES .. LAG .. LEAD
COEFFICIENTS OF CORRELATION
COEFFICIENTS OF CORRELATION
EMPLOYMENT IN MASSACHUSETTS... DEATH RATE CITY OF BOSTON
JANUARY, 1903 THROUGH DECEMBER 1911
FOR VARIOUS PERIODS... DEGREES .. LAG .. LEAD
COEFFICIENTS OF CORRELATION

CHART 34c

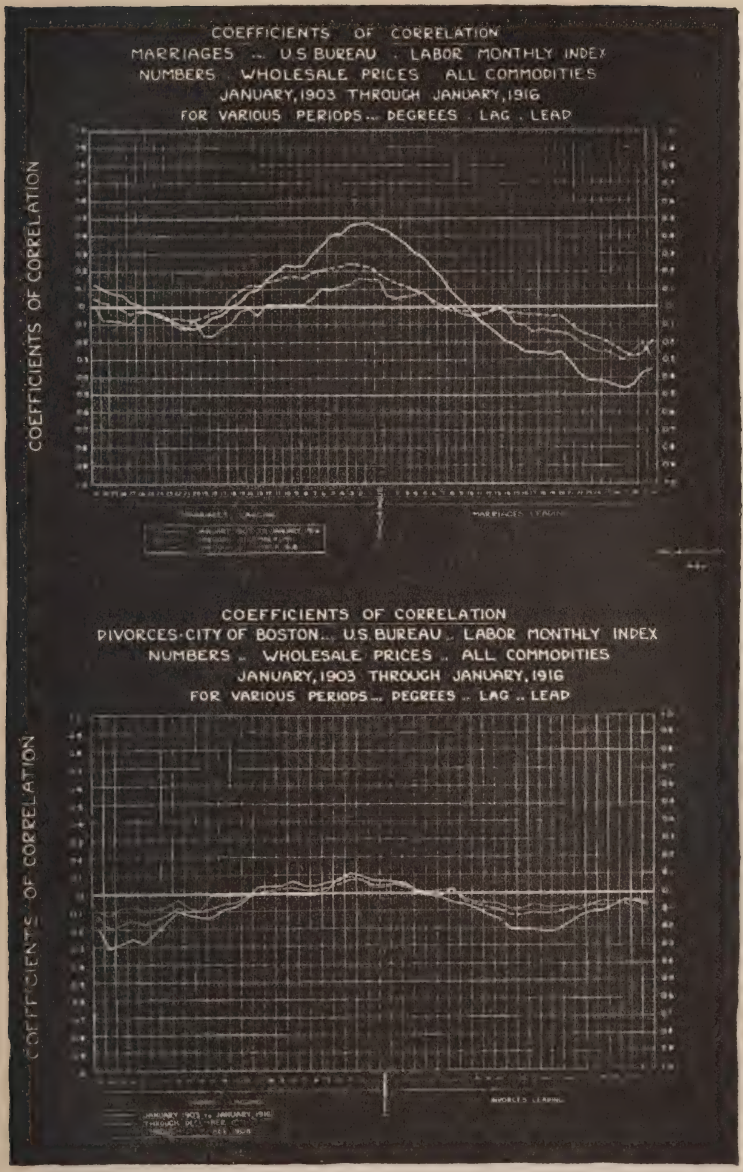
COEFFICIENTS OF CORRELATION
MARRIAGES ... U.S. BUREAU . LABOR MONTHLY INDEX
NUMBERS WHOLESALE PRICES ALL COMMODITIES
JANUARY, 1903 THROUGH JANUARY, 1916
FOR VARIOUS PERIODS ... DEGREES . LAG . LEAD
COEFFICIENTS OF CORRELATION
COEFFICIENTS OF CORRELATION
DIVORCES-CITY OF BOSTON ... U.S. BUREAU . LABOR MONTHLY INDEX
NUMBERS . WHOLESALE PRICES .. ALL COMMODITIES
JANUARY, 1903 THROUGH JANUARY, 1916
FOR VARIOUS PERIODS ... DEGREES .. LAG .. LEAD
COEFFICIENTS OF CORRELATION

CHART 34d

There are certain very interesting features in the above tabulation. First note that the coefficients are all positive with the exception of the one representing the covariation of divorces and wholesale prices, and the one representing the covariation between the death-rate and unemployment. The latter coefficient becomes positive when the death-rate leads by twenty-five months. The next feature to be noted is that the correlations between the birth-rate and both wholesale prices and unemployment are higher than the coefficients found when comparing the death-rate with those same correlatives. This indicates that the birth-rate is more delicately adjusted to cyclical fluctuations than is the death-rate. We next direct attention to the lower coefficient reached for marriage and wholesale prices than for birth-rate and death-rate with the same correlative. We conclude that, in cyclical fluctuations, marriage is not so much controlled as is the birth-rate; and, further, that marriage is not as delicately adjusted to variations in business enterprise as is the death-rate. It is highly interesting, also, to note that the coefficient reached for divorce is low compared with others found in this study. This bears out the interpretation given above concerning the post-War rise in the number of divorce libels filed. We concluded that cyclical fluctuations in divorce had little to do with business variations.

CHAPTER IX

SOCIAL ASPECTS OF THE ORIGIN OF BUSINESS CYCLES

DURING the past fifteen years, strides have been made in the investigation of business cycles. We know much of the sequence of events in the various phases of the cycle. This knowledge has been wrung, with the powerful aid of modern mathematical statistics, from incomplete data, or data collected for other purposes, or even data accidentally resulting from given situations. The descriptions of these sequences have that firm foundation which results from a proper use of mathematical analysis. These advances in knowledge of business enterprise have been made because economists[1] anticipated the suggestion made by Arne Fisher: "The genius of the Italian renaissance, Leonardo da Vinci, as early as 1479 proclaimed that 'no part of human knowledge could lay claim to the title of science before it had passed through the stage of mathematical demonstration.' Comparatively few branches of learning measure up to the standard of Leonardo da Vinci, and our learned friends among the economists and sociologists

[1] Sociologists, too, are beginning to attempt mathematical analyses of their problems. Too much credit cannot be given to Professor Karl Pearson and his loyal staff of disciples and students for the stimulus they have given to the application of mathematical methods to sociological problems. Compare, for example, Number 10 in the Studies in National Deterioration, Drapers' Company Research Memoirs (which is a study of the data provided by a baby clinic in a large manufacturing town, by Mary Noel Karn and Karl Pearson, Cambridge, 1922), with the current output of medical and sociological investigations. Professor Raymond Pearl's *Medical Biometry and Statistics* (Philadelphia 1923) will stimulate proper method even in medical investigations.

have a long road to travel before they succeed in placing their methods in the coveted niche of science." [1]

Despite the knowledge which we now have of the sequence of events during business cycles, we know comparatively little about the origin. Various [2] suggestions have been offered. Most of these help to a better understanding of the rhythmic succession. We need, however, further description of processes and their relation to other forces. Later it may be possible to arrive at a clearer understanding of causal, or, at least, associational relationships.[3] The various explanations which have been offered to account for the origin of business cycles have been classified by Professor Alvin H. Hansen [4] as follows:

A. Economic Theories.
   I. Those that emphasize Producers' Demand.
   II. Those that emphasize Consumers' Demand.
   III. Those that emphasize Money, Credit, Prices, and Capitalization.
B. Meteorological Theories.

[1] Arne Fisher, *Frequency Curves* (New York, 1922), p. 5. In this connection note also the following quotations from La Place and Lord Kelvin, quoted by Karl Pearson in *Tables for Statisticians and Biometricians* (Cambridge, 1914), p. viii. "La Théorie des probabilités n'est au fond que le bon sens réduit au calcul; elle fait apprécier avec exactitude ce que les esprits justes sentent par une sort d'instinct sans qu'ils puissent souvent s'en rendre compte." (La Place.) "When you measure what you are speaking about and express it in numbers, you know something about it, but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind." (Lord Kelvin.)

[2] Ellsworth Huntington in *World Power and Evolution* (New Haven, 1919), p. 26, says: "A recent writer estimates that there have been two hundred and thirty distinct answers to this (the origin of business cycle) question." Huntington then bravely adds another.

[3] Description as a philosophy of science holds a unique place in Professor Pearson's system. See his *Grammar of Science.*

[4] Alvin Harvey Hansen, *Cycles of Prosperity and Depression in the United States, Great Britain and Germany*, University of Wisconsin Studies in the Social Sciences and History, No. 5 (Madison, 1921), p. 80.

The suggestion we have to offer concerning one phase of the origin of business cycles falls within still another group. It may be termed psychological. Our suggestion deals primarily with the thoughts and emotions of men. We do not mean to suggest that psychological theories of the origin of business cycles are new; such is not the case. Nor do we intend to imply that such theories are adequate. It is not unlikely that all the theories now offered will have a part, eventually, in explaining business cycles.

In this study we have seen that fluctuations in conceptions *precede* fluctuations in wholesale prices by about eight months; fluctuations in the birth-rate *precede* fluctuations in unemployment by about seventeen months. We have further noted that fluctuations in the death-rate *precede* fluctuations in wholesale prices about seventeen months; and that fluctuations in the death-rate *precede* fluctuations in unemployment by about ten months. Dr. Huntington [1] says: "The statistics from 1870 to the Great War show that a high death-rate regularly *precedes* hard times, while a low death-rate *precedes* prosperity. By no possibility can the reverse be made to appear the case. Health is a *cause* far more than effect."

The social relationships discussed in this book are not the only ones which have been studied with reference to

[1] Ellsworth Huntington, *op. cit.*, p. 29. The data used by Dr. Huntington refer to Massachusetts, New York City, Chicago, Connecticut, and other parts of New England. The present writer doubts Dr. Huntington's method more than he questions the validity of his suggestion of the origin of business fluctuations in variations in health indexes. Dr. Huntington has utilized the graphic method of comparison. This method is liable to lead to false conclusions, especially where the question of lag or lead is all important. Although Dr. Huntington has offered a psychological theory to explain the origin of business cycles by referring to the precedence of fluctuations in the death-rates (he inverts the death-rate curve to obtain an index of health) over fluctuations in economic conditions, he brings his theory under the class of meteorological explanations by urging the correlation between the weather and health.

business cycles. Other writers have shown correlations for suicide,[1] relief cases,[2] immigration,[3] strikes,[4] crime,[5] religiosity,[6] attempts at industrial democracy,[7] consumption of alcoholic beverages,[8] and, of course, unemployment.[9] So far, however, we have not been able to find any studies of these social consequences of business cycles which, dealing with data in the shape of monthly reports, have carefully analyzed the time-relationships. No studies are available in which coefficients have been worked out for correlations between series which reflect human incidents and series which reflect the market place when fluctuations in the former precede fluctuations in the latter. These correlative social series have usually been analyzed to determine the degree to which they follow business variations.

In the *Boston Traveler*, March 8, 1924, Frederic H. Curtiss, Chairman of the Board of Directors of the Federal Reserve Bank of Boston and Federal Reserve Agent, alludes to the remark made by President Wilson about

[1] W. F. Ogburn and D. S. Thomas, *loc. cit.*, pp. 337–38.

[2] Katherine E. Howland, "A Statistical Study of Poor Relief," *Journal of the American Statistical Association*, vol. XVIII (December, 1922), pp. 480–89; Maurice B. Hexter, "The Business Cycle, Relief Work, and Desertion," *The Jewish Social Service Quarterly*, vol. I, No. 1 (February, 1924), pp. 3–33.

[3] Warren S. Persons, "Construction of a Business Barometer, Based on Annual Data," *American Economic Review* (December, 1916), pp. 739–69; see also *Indices of General Business Conditions*, p. 38.

[4] Alvin H. Hansen, "Cycles of Strikes," *American Economic Review* (December, 1921), p. 648.

[5] George R. Davies, *loc. cit.*, p. 114; Ogburn and Thomas, *loc. cit.*, p. 339.

[6] George R. Davies, *loc. cit.*, p. 111.

[7] Paul H. Douglas, "Personnel Problems and the Business Cycle," *Administration* (July, 1922); W. F. Ogburn, "The Effects of Business Conditions on Social Programs," *Associations Monthly* (October, 1921); V. W. Lanfear, "Business Fluctuations and the American Labor Movement," *Columbia Studies in History, Economics and Public Law*, vol. CX, No. 2 (New York, 1924), pp. 15–16.

[8] George R. Davies, *loc. cit.*, p. 111.

[9] William A. Berridge, *Cycles of Unemployment in the United States, 1903–1922*, Pollak Publication, Number Four.

the depression of 1914 being a psychological depression. Mr. Curtiss says: "A 'psychological' depression is not less real than one brought on by a money panic or an important crop failure." Stanley Jevons [1] many years ago maintained that "periodic collapses are really mental in their nature, depending upon variations of despondency, hopefulness, excitement, disappointment and panic." "But," he added, "it seems to be very probable that the moods of the commercial mind, while constituting the principal part of the phenomena, may be controlled by outward events, especially the conditions of the harvests." Professor Pigou introduces his discussion of "The Psychological Tendencies of the Business Community" as follows: "A third true cause of the wave movements in industrial activity generally may be found in the psychological tendencies of the business community. The attitude of business men toward the signs of the times does not remain constant, but varies from period to period between errors of optimism and errors of pessimism." [2]

Concerning the effect upon business cycles of health fluctuations, Dr. Huntington [3] says: "At certain times . . . a wave of optimism goes over the community. Many men feel that now is the time for an advance. It is time for the railroad in which they are interested to double-track a new section, run a spur to a new manufacturing town, and improve the stations. Others say it is time to build a factory, boom a neglected mining property, open a new chain of drug stores, or make a market for a new brand of baking powder. One man's optimism, so it is said, communicates itself to another, and thus the idea of expansion is in the air. Our study of health makes us

[1] Stanley Jevons, *Investigations in Currency and Finance* (London, 1884), p. 184.

[2] A. C. Pigou, *The Economics of Welfare* (London, 1920), p. 831.

[3] *Op. cit.*, pp. 54–57.

believe that this phrase 'in the air' is literally true. . . . Not only does the death-rate drop to a low level, but sicknesses are rare, people do not suffer so much as usual from colds and headaches, and those who are well have a feeling of strength and buoyancy. We all know that feeling, and we know that it makes us hospitable to new ideas. The ideas that have been floating in men's minds seem more feasible than formerly, the difficulties do not seem so formidable. Hence one man here and another there makes a final decision which may have been hanging fire for a long time. Thus a long train of circumstances is set in motion.

"Consider your own case. Your financial, social, and moral condition may be exactly the same at two different times. Yet at one time you lie awake at night and wonder whether you can ever pull through. Something that cannot happen for a year — and that may not happen then — seems like a mountain of difficulty. You get up in the morning determined to play your part perhaps, but dull and hopeless. No, you are not sick. You believe that your judgment is as good as ever, but something is wrong — with the world. A few months later everything is different. You drop asleep as soon as you go to bed; your worries seem to be gone; you can meet that debt; you can build that new wing to the factory; you can increase your sales. The man who seemed three months ago to be your greatest enemy is relatively harmless. Of course he did not do the fair thing, but after all he can't hurt you, and anyhow the poor chap deserves pity with a sick, nervous wife like that. So you go about your business hopefully, although the actual facts are no better and no worse than they were when you were so depressed."

We noted above that Jevons alluded to the effect upon business fluctuations of the mental attitudes of men; we

noted the emphasis put upon the same connection by Professor Pigou. We note here the effect which Professor Huntington points out of good and poor health upon business. The connection which Jevons suggested between business and climate turned on the effect of meteorological conditions upon crops; the connection between climate and business urged by Dr. Huntington is based upon the effect of weather upon health and the subsequent effect of health upon business.

There can be no doubt that the social series, which we have shown to precede cyclical fluctuations in economic series, reflect powerful occurrences in society. Not only do they indicate these occurrences, but they determine many others. The death-rate, for example, may be representative, in a crude way, of the morbidity existing at any particular moment. The birth-rate, too, reflects deep-seated changes in the emotions of men. Physical states may and do determine psychological attitudes, even though the Russian Pavlov and his disciples have shown, through their studies of the conditioned reflex, that psychological attitudes under certain circumstances determine physical changes. We can stay close to reality and throw out the suggestion that these fluctuations in the birth-rate and the death-rate may possibly have something to do with the early beginnings of business fluctuations.

Let us see how this may occur. A man leaves a sick child at home. He goes to a meeting of the directors of his corporation. A project to expand and capture new markets is suggested. The man cannot devote his full thought to the discussion: his mind is in the sick room at home. He proposes that the decision go over until the next meeting. His emotions are infectious. He carries his point.

Another man leaves the hospital after calling on a sick friend. He begins to ponder on the purposes and plans of life. He asks the eternal question: Whither away? He wonders whether it is all worth while. He goes to his office. Decisions must be made, but he cannot concentrate. He can forget neither his sick friend nor his philosophical speculations. Under the circumstances he postpones decisions.

Still another is told on his return home that a child can be expected in due course. He is thrilled. He must prepare financially for its coming. He quickens his efforts. He wants to rise higher in his field of endeavor. He works harder and better. He achieves more. His results reflect his redoubled efforts.

Such instances of the actual effect of deaths and births upon men are not unusual.[1] Biographies and autobiographies are full of them. The stage reflects them. Can there be any doubt that there is a close connection between these fluctuations in birth-rate and death-rate and fluctuations in business enterprise? Business enterprise is the application of mental effort to the transformation of our physical environment. Anything which affects the emotions of men must necessarily affect their ability to make decisions, anticipate decisions, or postpone decisions. If these times of postponed decisions or accelerated judgments or stimulated efforts are not isolated, but, on the contrary, run in wave-like movements, we think that there may be something to the suggestion

[1] It is plain, too, that the effect of cycles of births and deaths would repeat themselves for a number of years. The children born, say, in March, 1920, would enter school in September, 1926. The anniversary services and remembrances of deaths would likewise recur. In other words, the ceremonial institutions of society would make the economic reverberations of the cyclical fluctuations in births and deaths felt for many years after their original occurrence.

that varying birth-rates and fluctuating death-rates can and do affect business cycles. The errors of optimism and the errors of pessimism [1] may be closely connected with these variations in human emotions. It may well be that these waves of emotion which run through society from time to time are very closely related to these variations in births and deaths.

The writer is very far from regarding fluctuations in the birth-rate and the death-rate as the sole cause of the origin of business cycles. He gives much weight to explanations of origin which turn on the fiscal side of business [2] and those which emphasize variations in consumers' demand or in producers' demand. He does not regard the theories of the self-generating business cycle as valueless. He does submit, however, that some of the findings of the present study indicate that most economists, in their study of the origin of the business cycle, have overlooked important psychological forces. He

[1] See A. C. Pigou, *op. cit.*, pp. 831–48.

[2] This suggests the interesting question: does the market place determine life or does life determine the market? In other words, the contest lies between economic determinism and psychological determinism. Professor Davies writes as follows: "The social aspects of the business cycle suggest the question of economic determinism. The priority of economic interests seems to be indicated by the fact that it is possible to secure various correlations about the economic data of the cycle. But it does not appear feasible to reverse the process and to correlate the various series about, let us say, the religious interest, or the marriage-rate. Whether the market dominates life or not, it appears at least to be the common center. Perhaps this central position results from the fact that economic goods and processes are so radically affected by the advance of the human intellect, while those things which are more closely related to the emotional life, as the home, the church, and morals, do not so materially change. Therefore the market acts dynamically upon other interests, while these in return respond or react more passively. And, of course, material interests necessarily serve as a common foundation for other interests. Thus the progressive cycle is a complex of interacting forces none of which can be regarded as primary. Only some general factor like the growth of the mind itself, or the environmental conditions which stimulate this growth, can be said to be the impelling cause urging society forward in irregular pulsations." (*Loc. cit.*, p. 118.)

suggests that in these human occurrences which come to most men, capitalists and common laborers alike, we have the sources of most human emotions, and that these emotions affect every field of man's endeavor. Further study of these sources of variations in human emotions may throw much more light on obscure points in economic theory.

APPENDIX

TABLE 2. ORDINATES OF TREND, THE BIRTH-RATE IN THE CITY OF BOSTON

YEAR	January	February	March	April	May	June	July	August	September	October	November	December
1900	28.2306	28.2213	28.2120	28.2027	28.1934	28.1841	28.1748	28.1665	28.1562	28.1469	28.1376	28.1283
1901	28.1190	28.1097	28.1004	28.0911	28.0818	28.0725	28.0632	28.0539	28.0446	28.0353	28.0260	28.0167
1902	28.0074	27.9981	27.9888	27.9795	27.9702	27.9609	27.9516	27.9423	27.9330	27.9237	27.9144	27.9051
1903	27.8958	27.8865	27.8772	27.8679	27.8586	27.8493	27.8400	27.8307	27.8214	27.8121	27.8028	27.7935
1904	27.7842	27.7749	27.7656	27.7563	27.7470	27.7377	27.7284	27.7191	27.7098	27.7005	27.6912	27.6819
1905	27.6726	27.6633	27.6540	27.6447	27.6354	27.6261	27.6168	27.6075	27.5982	27.5889	27.5796	27.5703
1906	27.5610	27.5517	27.5424	27.5331	27.5238	27.5145	27.5052	27.4959	27.4866	27.4773	27.4680	27.4587
1907	27.4494	27.4401	27.4308	27.4215	27.4122	27.4029	27.3936	27.3843	27.3750	27.3657	27.3564	27.3471
1908	27.3378	27.3285	27.3192	27.3099	27.3006	27.2913	27.2820	27.2727	27.2634	27.2541	27.2448	27.2355
1909	27.2262	27.2169	27.2076	27.1983	27.1890	27.1797	27.1704	27.1611	27.1518	27.1425	27.1332	27.1239
1910	27.1146	27.1053	27.0960	27.0867	27.0774	27.0681	27.0588	27.0495	27.0402	27.0309	27.0216	27.0123
1911	27.0030	26.9937	26.9844	26.9751	26.9658	26.9565	26.9472	26.9379	26.9286	26.9193	26.9100	26.9007
1912	26.8914	26.8821	26.8728	26.8635	26.8542	26.8449	26.8356	26.8263	26.8170	26.8077	26.7984	26.7891
1913	26.7798	26.7705	26.7612	26.7519	26.7426	26.7333	26.7240	26.7147	26.7054	26.6961	26.6868	26.6775
1914	26.6682	26.6589	26.6496	26.6403	26.6310	26.6217	26.6124	26.6031	26.5938	26.5845	26.5752	26.5659
1915	26.5566	26.5473	26.5380	26.5287	26.5194	26.5101	26.5008	26.4915	26.4822	26.4729	26.4636	26.4545
1916	26.4450	26.4357	26.4264	26.4171	26.4078	26.3985	26.3892	26.3799	26.3706	26.3613	26.3524	26.3427
1917	26.3334	26.3241	26.3148	26.3055	26.2962	26.2869	26.2776	26.2683	26.2590	26.2497	26.2404	26.2311
1918	26.2218	26.2125	26.2032	26.1939	26.1846	26.1753	26.1660	26.1567	26.1474	26.1381	26.1288	26.1195
1919	26.1102	26.1009	26.0916	26.0823	26.0730	26.0637	26.0544	26.0451	26.0358	26.0265	26.0172	26.0079
1920	25.9986	25.9893	25.9800	25.9707	25.9614	25.9521	25.9428	25.9335	25.9242	25.9149	25.9056	25.8963
1921	25.8870	25.8777	25.8684	25.8591	25.8498	25.8405	25.8312	25.8219	25.8126	25.8033	25.7940	25.7847

TABLE 3. DEVIATION FROM TREND, THE BIRTH-RATE IN THE CITY OF BOSTON

YEAR	January	February	March	April	May	June	July	August	September	October	November	December
1900	107.22	101.34	107.29	89.71	101.58	105.41	106.58	112.01	99.80	107.65	103.78	105.23
1901	99.93	96.59	100.00	91.81	90.56	98.39	100.99	100.52	100.55	100.59	97.41	100.26
1902	104.76	91.54	101.47	86.85	99.06	91.99	100.24	99.06	97.73	94.26	100.63	102.24
1903	102.63	92.16	102.20	93.55	94.55	95.51	95.83	99.24	99.28	95.07	96.21	100.94
1904	98.26	97.57	97.60	93.24	94.71	97.99	95.25	98.96	95.63	98.55	96.56	98.73
1905	99.37	91.46	105.01	94.41	90.97	89.41	105.01	105.77	96.93	94.82	92.82	101.92
1906	98.40	87.47	103.73	95.70	95.55	106.13	110.16	110.20	108.78	107.87	103.76	104.92
1907	106.74	98.07	114.58	105.32	103.24	109.11	106.59	111.96	105.75	106.70	107.47	115.91
1908	104.00	101.29	113.84	102.93	111.35	106.08	110.22	105.23	101.82	104.50	104.61	102.45
1909	104.68	99.94	108.06	93.02	100.48	98.35	97.53	101.87	99.81	100.58	92.88	98.62
1910	98.47	92.97	99.65	97.94	100.01	100.04	104.99	100.93	98.00	98.48	93.22	96.88
1911	102.66	92.02	99.72	98.61	96.38	96.45	99.53	104.31	94.32	97.33	92.90	102.23
1912	97.80	102.67	104.19	90.09	104.64	104.30	105.83	104.00	101.80	97.51	92.99	101.31
1913	100.22	95.25	103.88	98.05	100.70	100.32	100.10	103.76	102.23	100.76	92.93	98.58
1914	105.07	92.65	107.69	100.15	102.17	99.17	102.70	101.38	102.77	97.05	97.84	98.32
1915	94.78	98.39	103.70	103.74	101.81	99.21	104.53	103.05	96.44	102.75	92.54	101.68
1916	95.67	95.70	109.36	98.80	99.21	96.98	102.85	101.78	96.74	100.49	102.84	95.43
1917	104.05	93.83	104.50	96.94	102.11	101.69	101.61	103.09	97.95	97.98	89.71	94.89
1918	99.73	91.94	104.57	101.17	97.65	97.31	105.48	102.08	105.10	98.09	84.35	94.64
1919	81.96	111.49	96.74	97.77	86.56	80.19	85.90	89.69	101.78	102.55	90.40	104.97
1920	94.85	101.16	107.70	94.03	98.30	104.50	101.03	107.39	103.19	98.86	88.17	92.25
1921	87.42	88.38	107.20	103.37	98.18	97.25	94.50	107.82	106.27	94.33	96.15	94.59

TABLE 4. LINK RELATIVES, THE BIRTH-RATE IN THE CITY OF BOSTON

YEAR	January / December	February / January	March / February	April / March	May / April	June / May	July / June	August / July	September / August	October / September	November / October	December / November
1900		94.52	105.87	83.61	113.23	103.77	101.11	105.09	89.10	107.87	96.41	101.40
1901	94.96	96.66	103.53	91.81	98.64	88.65	102.64	99.53	100.03	100.04	96.84	102.93
1902	104.49	87.38	110.85	85.59	74.06	92.86	108.97	98.82	98.66	96.45	106.76	101.60
1903	100.38	89.80	110.89	91.54	101.07	101.02	100.34	103.56	100.04	95.76	101.20	104.92
1904	97.34	99.30	100.03	95.53	101.58	103.46	97.20	103.90	96.64	103.05	97.98	102.25
1905	100.65	92.04	114.82	89.91	96.36	98.29	117.45	100.72	91.64	97.82	97.89	109.80
1906	96.55	88.89	118.68	92.26	99.84	111.07	103.80	100.04	98.71	99.16	96.19	101.12
1907	101.73	91.88	116.83	91.91	98.03	105.69	97.69	105.04	94.45	100.90	100.72	107.85
1908	89.72	97.39	112.39	90.42	108.18	95.27	103.90	95.47	96.76	102.63	100.11	97.94
1909	102.18	95.47	108.75	86.08	108.02	97.88	99.17	104.45	97.98	100.77	92.34	106.18
1910	99.85	94.41	107.19	98.28	102.11	100.03	104.95	96.13	97.10	100.48	94.86	103.93
1911	105.97	89.64	108.37	98.89	97.74	100.07	103.19	104.80	90.42	103.19	95.45	110.04
1912	95.67	104.98	101.48	86.47	116.15	99.68	101.47	98.27	97.88	95.78	95.36	108.95
1913	98.92	95.04	109.06	94.39	102.70	99.62	99.78	103.66	98.53	98.56	92.23	106.08
1914	106.58	88.18	116.23	93.00	102.07	97.06	103.56	98.71	101.37	94.43	100.81	100.49
1915	96.40	103.81	105.40	100.04	98.13	97.45	105.36	98.58	93.59	106.54	90.06	109.88
1916	94.09	100.03	114.27	90.34	100.41	97.75	106.05	98.96	95.05	103.88	102.34	92.79
1917	109.03	90.18	111.37	92.77	105.33	99.59	99.92	101.46	95.01	100.03	91.56	105.77
1918	105.10	92.19	113.74	96.75	96.52	99.65	108.40	96.78	102.96	93.33	85.99	112.20
1919	86.60	136.03	86.77	101.06	88.53	92.64	107.12	104.41	113.48	100.76	88.15	116.12
1920	90.36	106.65	106.47	87.31	104.54	106.31	96.68	106.30	96.09	95.80	89.19	104.63
1921	94.76	101.10	121.29	96.43	94.98	99.05	97.17	114.10	98.56	88.76	101.93	98.38

TABLE 6. DEVIATION FROM TREND MINUS SEASONAL FACTOR, THE BIRTH-RATE IN THE CITY OF BOSTON

YEAR	January	February	March	April	May	June	July	August	September	October	November	December
1900	+ 8.40	+ 1.43	+ .31	− 9.08	+ 2.24	+ 6.50	+ 5.08	+ 9.57	+ .13	+8.13	+ 8.17	+ 5.14
1901	+ 1.11	− 3.32	− 7.50	− 6.98	− 8.78	− .52	− .51	− 1.92	+ .88	+1.07	+ 1.80	+ .17
1902	+ 5.94	− 8.37	− 6.03	−11.94	− .28	− 6.92	− 1.36	− 3.38	−1.94	−5.26	+ 5.02	+ 2.15
1903	+ 3.81	− 7.75	− 5.30	− 5.24	− 4.79	− 3.40	− 5.67	− 3.20	− .39	−4.45	+ .60	+ .85
1904	− .56	− 2.34	− 9.90	− 5.55	− 4.63	− .92	− 6.25	− 3.48	−4.04	− .97	+ .95	− 1.36
1905	+ .55	− 8.45	− 2.49	− 4.37	− 8.37	− 9.50	+ 3.51	+ 3.33	−2.74	−4.70	− 2.79	+ 1.83
1906	− .42	−12.44	− 3.77	− 3.03	− 3.79	+ 7.22	+ 8.66	+ 8.24	+9.11	−8.35	+ 8.15	+ 4.83
1907	+ 8.50	+ 1.84	+ 7.08	+ 6.53	+ 3.90	+10.20	+ 5.09	+ 9.52	+6.08	−6.18	+11.86	+15.42
1908	+ 5.19	+ 1.38	+ 6.34	+ 4.14	+12.01	+ 7.17	+ 8.72	+ 3.21	+2.15	−4.98	+ 9.00	+ 2.36
1909	+ 5.87	+ .03	+ .56	− 5.37	+ 1.14	− .56	− 3.97	− .57	+ .14	+1.06	− 2.73	− 1.47
1910	+ .23	− 6.94	− 7.85	− .85	+ .67	+ 1.13	+ 3.49	− 1.51	−1.67	−1.04	− 2.39	− 3.21
1911	+ 4.32	− 7.89	− 7.78	− .18	− 2.96	− 1.46	− 1.97	+ 2.07	−5.35	−2.19	− 2.71	+ 2.14
1912	− .44	+ 2.76	− 3.31	− 8.79	+ 5.30	+ 5.39	+ 4.33	+ 1.56	+2.13	−2.01	− 2.62	+ 1.22
1913	+ 1.98	− 4.66	− 3.62	− .74	+ 1.36	+ 1.41	− 1.44	+ 1.32	+2.56	+1.24	− 2.68	− 1.51
1914	+ 6.83	− 7.26	+ .19	+ 1.36	+ 2.83	+ .26	+ 1.20	− .06	+3.10	−2.47	+ 2.23	− 1.77
1915	− 3.46	− 1.52	− 3.80	+ 4.95	+ 2.47	+ .30	+ 3.03	+ .61	−3.23	+3.23	− 3.07	+ 1.59
1916	− 2.47	− 4.21	+ 1.86	+ .01	− .07	− 1.93	+ 1.35	− .66	−2.93	+ .97	+ 7.23	− 4.66
1917	+ 5.81	− 6.08	− 3.00	− 1.85	+ 2.77	+ 2.78	+ .11	+ .65	−1.72	−1.54	− 5.90	− 5.20
1918	+ .49	− 7.97	− 2.93	+ 2.38	− 1.69	− 1.60	+ 3.98	− .36	+5.43	−1.43	−11.26	− 5.45
1919	−16.28	+11.58	−10.76	− 1.02	−12.78	−18.72	−15.60	−12.75	+2.11	+3.03	− 5.21	+ 4.88
1920	− 3.39	+ 1.25	+ .20	− 4.76	− 1.04	+ 5.69	− .47	+ 4.85	+3.52	− .66	− 7.44	− 7.84
1921	−10.82	−11.53	− .30	+ 4.58	− 1.16	− .66	− 6.00	+ 5.38	+6.60	−5.19	+ .54	− 5.50

TABLE 12. ORDINATES OF TREND, MONTHLY STILLBIRTH-RATE PER 1000 POPULATION IN THE CITY OF BOSTON

YEAR	January	February	March	April	May	June	July	August	September	October	November	December
1900	1.066629	1.066242	1.065855	1.065468	1.065081	1.064694	1.064307	1.063920	1.063533	1.063146	1.062759	1.062372
1901	1.061985	1.061598	1.061211	1.060824	1.060437	1.060050	1.059663	1.059276	1.058889	1.058502	1.058115	1.057728
1902	1.057341	1.056954	1.056567	1.056180	1.055793	1.055406	1.055019	1.054632	1.054245	1.053858	1.053471	1.053084
1903	1.052697	1.052310	1.051923	1.051536	1.051149	1.050762	1.050375	1.049988	1.049601	1.049214	1.048827	1.048440
1904	1.048053	1.047666	1.047279	1.046892	1.046505	1.046118	1.045731	1.045344	1.044957	1.044570	1.044183	1.043796
1905	1.043409	1.043022	1.042635	1.042248	1.041861	1.041474	1.041087	1.040700	1.040313	1.039926	1.039539	1.039152
1906	1.038765	1.038378	1.037991	1.037604	1.037217	1.036830	1.036443	1.036056	1.035669	1.035282	1.034895	1.034508
1907	1.034121	1.033734	1.033347	1.032960	1.032573	1.032186	1.031799	1.031412	1.031025	1.030638	1.030251	1.029864
1908	1.029477	1.029090	1.028703	1.028316	1.027929	1.027542	1.027155	1.026768	1.026381	1.025994	1.025607	1.025220
1909	1.024833	1.024446	1.024059	1.023672	1.023285	1.022898	1.022511	1.022124	1.021737	1.021350	1.020963	1.020576
1910	1.020189	1.019802	1.019415	1.019028	1.018641	1.018254	1.017867	1.017480	1.017093	1.016706	1.016319	1.015932
1911	1.015545	1.015158	1.014771	1.014384	1.013997	1.013610	1.013223	1.012836	1.012449	1.012062	1.011675	1.011288
1912	1.010901	1.010514	1.010127	1.009740	1.009353	1.008966	1.008579	1.008192	1.007805	1.007418	1.007031	1.006644
1913	1.006257	1.005870	1.005483	1.005096	1.004709	1.004322	1.003935	1.003548	1.003161	1.002774	1.002387	1.002000
1914	1.001613	1.001226	1.000839	1.000452	1.000065	0.999678	0.999291	0.998904	0.998517	0.998130	0.997743	0.997356
1915	0.996969	0.996582	0.996195	0.995808	0.995421	0.995034	0.994647	0.994260	0.993873	0.993486	0.993099	0.992712
1916	0.992325	0.991938	0.991551	0.991164	0.990777	0.990390	0.990003	0.989616	0.989229	0.988842	0.988455	0.988068
1917	0.987681	0.987294	0.986907	0.986520	0.986133	0.985746	0.985359	0.984972	0.984585	0.984198	0.983811	0.983424
1918	0.983037	0.982650	0.982263	0.981867	0.981489	0.981102	0.980715	0.980328	0.979941	0.979554	0.979167	0.978780
1919	0.978393	0.978006	0.977619	0.977232	0.976845	0.976458	0.976071	0.975684	0.975297	0.974910	0.974523	0.974136
1920	0.973749	0.973362	0.972975	0.972588	0.972201	0.971814	0.971427	0.971040	0.970653	0.970266	0.969879	0.969492
1921	0.969105	0.968718	0.968331	0.967944	0.967577	0.967170	0.966783	0.966396	0.966009	0.965622	0.965235	0.964848

TABLE 13. DEVIATION FROM TREND, MONTHLY STILLBIRTH-RATE PER 1000 POPULATION IN THE CITY OF BOSTON

YEAR	January	February	March	April	May	June	July	August	September	October	November	December
1900	105.004	75.030	130.412	109.811	94.828	82.653	97.716	92.112	83.683	113.813	81.862	94.129
1901	82.864	100.791	90.463	82.954	113.161	89.618	37.748	109.509	87.828	115.257	73.716	121.960
1902	102.143	100.373	89.914	131.606	73.878	117.490	36.966	129.903	108.134	82.554	98.721	123.447
1903	113.993	100.731	100.768	104.609	120.820	118.961	50.458	105.715	99.085	107.700	85.810	85.842
1904	111.636	102.132	121.267	98.386	129.956	117.578	100.408	126.274	104.311	94.776	89.065	94.846
1905	111.174	112.174	112.216	113.217	91.183	122.903	103.738	113.385	82.667	117.316	103.892	98.157
1906	80.865	127.121	99.230	96.376	117.622	117.666	134.113	101.346	92.693	116.876	92.763	79.265
1907	111.206	116.084	120.966	117 139	100.719	109.476	116.302	112.467	99.901	120.314	98.034	142.737
1908	169.018	89.399	100.126	105.999	92.419	115.810	88.594	110.054	81.841	92.593	121.879	76.081
1909	123.923	122.017	112.298	100.618	116.292	101.672	115.402	95.879	117.447	99.868	92.070	87.206
1910	99.981	94.136	100.057	98.133	103.079	100.171	108.069	101.230	89.471	96.390	94.459	95.479
1911	117.178	95.552	122.195	94.639	95.661	101.617	98.695	113.543	89.881	99.796	119.604	89.984
1912	124.641	101.928	105.927	93.093	122.851	106.049	83.285	103.155	100.218	103.234	117.176	100.333
1913	105.341	93.451	110.394	110.437	82.611	117.492	100.604	102.636	95.698	105.707	105.748	95.808
1914	102.834	113.860	100.915	112.949	137.991	111.036	88.062	114.125	89.132	89.185	120.271	123.326
1915	89.268	84.288	115.439	81.341	104.478	84.419	93.501	90.520	96.592	78.511	83.577	117.859
1916	91.704	93.756	104.886	94.838	96.894	93.902	100.000	102.060	94.013	99.106	89.028	92.099
1917	92.135	86.094	91.194	84.134	91.266	89.272	91.337	92.388	86.331	88.397	78.267	84.399
1918	109.864	100.748	115.040	109.994	106.980	106.003	121.340	121.388	115.313	107.192	91.915	103.190
1919	104.253	80.777	77.740	81.864	79.849	86.025	61.471	98.393	87.153	65.647	89.274	92.390
1920	107.831	119.175	91.472	73.002	97.716	108.045	80.294	83.416	107.144	82.452	80.422	92.832
1921	84.614	78.454	70.224	84.716	84.750	74.444	93.092	110.721	81.780	83.884	84.953	84.987

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